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CHANGES IN THE SOFT PART COLORATION OF THE INDIAN REEF HERON, *EGRETTA GULARIS* (BOSC) RELATED TO AGE AND BREEDING STATUS[1]

B. M. Parasharya[2] and R. M. Naik[3]

Age dependent changes in the soft part coloration of the Indian Reef Heron, *Egretta gularis* (Bosc) from the day of hatching to adulthood are described. The nuptial colour changes in the soft parts are correlated with the nesting status.

Introduction

Coloration of the soft parts of the Indian Reef Heron, *Egretta gularis* (Bosc) changes with the age and breeding status, so that the coloration when viewed with other evidences gives a clue to the bird's age and breeding status; a knowledge of the soft part colour changes has been useful in some of our field studies on the heron. Moreover, in certain areas where the reef heron is sympatric with the Little Egret, *Egretta garzetta,* they tend to interbreed, and since a striking difference between the two species is coloration of their soft parts, we feel that a detailed description of the soft part colours at different stages of life in both the species should prove useful in further studies on the inter-relationship between the two herons.

Plumage colour variations and sequence of plumage changes in the reef heron are described earlier (Naik and Parasharya 1983). However, a brief review is necessary here. In the white as well as grey phases the natal down is white in most of the feather tracts, but it is subjected to some colour variation ranging from light grey to grey in the dorsal tract. The pin juvenile feathers start appearing, pushing out the natal down at the age of 6-8 days. The juvenile white plumage ranges from an almost pure white to one heavily dappled with grey. The juvenile grey is grey

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dorsally and light grey or white ventrally. The full adult plumage is attained at the age of 20-21 months. The adult white plumage is pure white and the adult grey is grey all over except the chin and throat which are white. Both the juvenile and adult grey plumages may, or may not, have wing patch of variable size on one or both the wings.

Before the breeding season a drooping nuchal crest of two narrow plumes develops in both the sexes and phases. In addition to the crest, filamentous ornamental feathers develop on the scapular region and long, narrow, lanceolate plumes on the lower parts of neck and upper breast. Nuptial feathers are shed just after the nesting is over, but in some cases it happens in April when the birds are still feeding their young, so that in the beginning of the breeding season (February) 90% of the birds may be with nuchal crest but during the second peak of breeding (July-August) only 40% may have it.

Materials and Methods

The present report is based on our field notes made during the studies on the distribution (Naik and Parasharya *in press*), breeding biology (Parasharya and Naik *in press*; Naik and Parasharya *in prep.*) and ecology of the reef heron (unpublished) and also on our observations of some captive birds maintained in our University aviary for studying the sequence of plumage changes and polymorphism (Naik and Parasharya 1983).

Observations

Colours of the soft parts described below are applicable to both the grey and white phases of the Reef Heron, unless mentioned otherwise. There were always a small number of *E. garzetta* and/or *garzetta-gularis* hybrids inter-breeding with *E. gularis* in the breeding colonies, so that some of the variations in the coloration of soft parts may possibly be attributed to the hybridization. The age dependent changes in the plumage and coloration of soft parts are summarized in Table 1.

Downy nestlings

Skin. The freshly hatched chicks have pink-yellow (flesh coloured) skin all over. The skin appears greyish green at the age of 3 days when the feather follicles deep within the skin start generating the juvenile plumage.

Eye. Iris colour of the freshly hatched chick is brown, and it remains so until the natal down is pushed out by the juvenile feathers.

Beak. The beak of freshly hatched chick is pinkish yellow with some brown at the tip of both the mandibles and base of the upper mandible. By the time the juvenile feathers start appearing as pin, the brown on the upper mandible has increased in density to be prominent. Though the brown on the lower mandible also tends to spread a little, the lower mandible continues to remain almost yellow throughout the downy plumage stage.

Legs. At the age of about 3 days, a slight green tinge appears on the tibia and upper tarsus and the feet start turning light yellow. Gradually the tibia and tarsus become light greyish green and the feet become light yellow, tinged with green.

Lore. Lore (facial skin) which is pink-yellow at the time of hatching gradually turns dark brown to grey.

Chicks in juvenile plumage and subadults

Skin. The skin which appears greyish green during the initial stage of the juvenile plumage growth, starts turning yellow after the age of 10 days, and it is conspicuously yellow

TABLE 1

A SUMMARY OF AGE-DEPENDENT CHANGES IN THE TYPE OF PLUMAGE AND COLORATION OF SOFT PARTS IN THE INDIAN REEF HERON

	0-day	1 Week	2 Weeks	1 month	6 months	20 months
Plumage type	natal down	juvenile in pin	juvenile	juvenile	juvenile	adult
Body skin	pinkish yellow	greyish green	yellow	yellowish grey	grey	grey
Eye	brown	brown	light brown	cream	yellow	yellow
Beak[1]	pinkish yellow	um-brown lm-yellow	yellow (base & tip brown)	yellow (base & tip brown)	yellow (base & tip brown)	yellow (usually)
Lore	pinkish yellow	dark brown to grey	brown	brown	yellow with traces of green	yellow (usually)
Tibia & tarsus	pinkish yellow	greyish green	yellowish green	greyish green	black with traces of green	black
Feet	pinkish yellow	light yellow	light yellow	light yellow	light yellowish with green tinge	yellow

[1] um = upper mandible, lm = lower mandible.

by about the 16th day. Later, the skin starts turning grey but the yellow tinge may continue to persist for a long period. However, all the birds acquire uniformly grey skin before reaching the age of 6 months.

Eye. Slight white tinge appears in the brown iris at the age of 11 days, and the brown progressively becomes lighter. The iris turns cream coloured by the age of 4 weeks and yellow by the age of 6 months.

Beak. The upper mandible is largely dark brown or grey and the lower one yellow when the juvenile feathers start appearing. By the age of 20 days, threefourths of the upper mandible becomes yellow, the brown being restricted to the base and tip. An overall appearance of the beak is yellow at the age of 4 weeks but the brown at the base and tip continues to persist and does not disappear completely even at the age of 6 months.

Legs and feet. When the pins of juvenile feathers appear, the tibia and tarsus are greyish green and the feet light yellow. The tibia and tarsus gradually turn yellowish green, but at the age of 15 days, a tinge of grey appears on the front face of the tarsus. At the end of 4 weeks, the tibia and tarsus are greyish green, and the frontal surface of the tarsus is marked with black bands. At the end of 6 months a slight dull green colour still persists on both the tibia and tarsus of some birds, though they have turned completely black in the others. The feet remain light yellowish green at least up to the age of 6 months, but thereafter they gradually turn light yellow.

Lore. The lore remains dark till 4 weeks of age. Thereafter, light greenish yellow colour appears among brown and gradually the yellow tinge increases to make the facial skin yellow with only a little tinge of green by the end of 6 months.

Adult

Eye. The iris of the adult bird is yellow.

Beak. The beak colour of the adult bird is variable. Variations in the beak colour are categorized into two basic types, yellow and black, which occur in the grey as well as white morphs in the non-breeding as well as breeding seasons. It may be mentioned here that the birds feeding in certain types of habitat often get their beak smeared with mud which on drying obscures the true beak colour (Naik *et al. unpublished*).

Yellow: This may range from pure yellow to pinkish. (a) Pure yellow: Both the mandibles are pure yellow. This is the most frequent beak type. (b) Pinkish yellow: Though the basic colour of both the mandibles is yellow, there is a pinkish tinge all over. Though infrequent, the pinkish yellow beak was recorded during the non-breeding season also.

Black: Both the mandibles are completely black without any yellow tinge.

Lore. The lore of the adult birds is yellow. Occasionally we came across birds that had small patches of blue on the yellow lore and also those with bluish green or blue lore.

Legs. In non-breeding adults, the tibia and tarsus are black and the feet are bright yellow. The bright yellow of feet often extends up to the distal end of tarsus.

Nuptial colour changes

The beak, lore and iris are usually yellow, but they acquire the nuptial colours during the courtship (pre-pairing and pair formation) stage of the nesting cycle. In both the grey and white phases, the beak usually remains yellow, but in some it may acquire a red tinge. If the bird happens to have a black beak, no recognisable change in the beak colour occurs.

The iris which is normally pale yellow turns to bright yellow and may even acquire a red rim in some birds. The lore turns to bright pink red or crimson. The feet and lower tarsus which are normally yellow turn to pink-red. The upper tarsus and thigh region which is dull grey normally do not change colour, but in some birds even these parts also acquire a red tinge. Pink-red in the feet and lore of the individuals perching alone (unpaired) is brighter than that of paired birds or nest-building birds. The pink colour tends to fade during the nest-building phase, and it almost completely fades out when the first egg is laid. The toes turn to pale orange-yellow and ultimately resume their original colour. The lore first turns to pale pink, then to bluish white and thereafter to pale yellow and ultimately to its original yellow colour. If a pair loses its clutch during the incubation period and if it is to re-build the nest, the nuptial colours return to the soft parts once again. The birds breeding in juvenile plumage also acquire nuptial colour when they start nesting.

We recorded the beak colour of 181 white-phase reef herons in different stages of their nesting cycle in breeding colony and the record is summarized in Table 2. These data illustrate some of the points we have made hereinbefore for both the phases, namely the yellow is the most frequent beak colour for the birds in every stage of the nesting cycle, the yellow beak may turn pinkish in some (but not in all) birds during the nesting season and a small proportion of birds have their beak black in colour which remains apparently unchanged through the nesting season.

Discussion

The age-dependent changes in the coloration of soft parts of Indian Reef Heron, described in this paper and summarized in Table 1 for the convenience of the readers, should be useful in ageing the chicks and distinguishing the older from younger juveniles in the field.

Table 2

Frequency of different beak colours of the white-phase reef herons in relation to their nesting status, as recorded in the New Port Colony, Bhavnagar

Nesting stage	Number of birds with designated beak colour			
	pinkish yellow	yellow	black	all combined
Unpaired	1	34	4	39
Courtship	2	20	4	26
Nest-building	2	22	4	28
With eggs	4	43	5	52
With chicks	1	31	4	36
All stages combined	10	150	21	181

In the present state of our knowledge it is not possible to say as to how much variation in the soft part coloration described here is attributed to hybridization between the Little Egret and reef heron that has been occurring since long in our area (Naik and Parasharya 1985) However, it is certain that the appearance of blue lore and black beak (which are characteristic features of the Little Egret) in our population of the reef heron is a result of gene flow from the Little Egret populations.

Nuptial colour changes in soft parts during early stages of the nesting cycle are now known to be widespread in the family Ardeidae (Blaker 1969). Ali and Ripley (1968) have mentioned colour changes asso-

ciated with breeding in many Indian Ardeidae, but not for the Indian Reef Heron. In certain populations of the reef heron in Africa, the beak turns from yellow to black as a part of nuptial colour changes (Hancock and Kushlan 1984). In our population of the reef heron, however, only noticeable change in the beak colour is for the yellow to turn pink-yellow in some birds. A few birds that we observed having pink-yellow beak in the non-breeding season were probably exceptional; an increased blood flow in the subcutaneous network of blood capillaries, either because of some emotional stress or premature hormonal changes, may have turned the beak pinkish.

Recently, Hancock and Kushlan (1984) have merged the reef heron with the Little Egret. These authors consider the Little Egret, *Egretta garzetta* (Linnaeus) as a polytypic species consisting of six subspecies, namely *garzetta* — an all white race with a range in the temperate, subtropical and tropical zones of the Old World, *nigriceps* — also an all-white race occurring on the islands of south-eastern Asia and the southwest Pacific, *immaculata* — also an all-white race of northern and eastern Australia, *gularis* — a polymorphic race on the west African coast from Mauritania to Gabon, *schistacea* — another polymorphic race distributed along the coastline extending from the west coast of Indian subcontinent to Persian Gulf and the Red Sea, and south along the African coast up to Tanzania, and *dimorpha* — also a polymorphic race found on Madagascar and other islands in and around Mozambique Channel. While available information on the soft part coloration of the above mentioned assemblage of herons are illustrated by Hancock and Kushlan (1984), detailed information of the changes in soft part coloration dependent on age and nesting status in these birds are urgently needed to understand their evolution.

Acknowledgement

One of us (B.M.P.) is grateful to the Council of Scientific and Industrial Research, New Delhi, for an award of Senior Research Fellowship.

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SURVEY OF THE FRESHWATER TURTLES OF INDIA PART II: THE GENUS *KACHUGA*[1]

EDWARD O. MOLL[2]

(*With two colour plates & four text-figures*)

[*Continued from Vol. 83*(3): 552]

Subgenus *Pangshura*

Contains four species — *smithii, sylhetensis, tecta* and *tentoria.* The subgenus is diagnosed by a suite of apomorphic or derived characteristics summarized in Table 1 and Figures 2-6. Members are small to moderate-sized species (< 30 cm CL) with pronounced sexual dimorphism which inhabit a variety of lentic and lotic habitats through much of India. The name is derived from "panshura," a Bengalese word for chelonian.

Kachuga smithii (Gray 1863)

Brown Roofed Terrapin — Plate III, A-C

Identification: A small species (to 23 cm CL) identifiable from other *Pangshura* by a relatively low, vaulted shell (H/CL < 44%) having only a weak, horizontal spine (or none) on the third vertebral scute.

Description: For coloration see descriptions of subspecies. Head moderate in size with short, tapering snout (less than length of orbit) projecting beyond lower jaw; skin at back of head divided into large irregular scales; upper jaw serrate, lacking medial notch or projection; alveolar surface broad, decked by a finely-serrate ridge on each side, converging but not meeting at midline. Lower jaw serrate with single, projecting tooth anteriorly, alveolar surface concave except for a median symphyseal ridge and a serrate ridge along lingual surface meeting symphyseal ridge at midline; coronoid process prominent. Hyoid moderately developed; ossified portions include a single-element body with a shallow, rounded notch posteriorly and a shallow "V" shaped notch anteriorly, a pair of small, rounded elements attached at either side of anterior notch (ceratohyals?), a narrow, elongate, outwardly-bowed pair of first ceratobranchial horns and a pair of short (2-3 times longer than wide) second ceratobranchial horns.

Shell oval, widest across a plane through seventh marginals; posterior margin of carapace slightly serrate; median keel low; raised areas at posterior of scutes not pronounced, obtuse; Vertebrals 1, 3 and 4 usually longer than wide, 2 and 5 usually wider than long; seam contact formula — 1M 4> 6M 8< 10>. Bridge long, exceeding length of either anterior (shorter) or posterior (longer) lobe of plastron; axillary somewhat smaller than inguinal scute; plastron truncate anteriorly; notched posteriorly; plastral formula — Ab> F> P> A> H> G.

Distribution: Brown roofed terrapins occur in the Indus, Ganges and Brahmaputra Drainages of Pakistan, Nepal, India, and Bangla-

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desh. Figure 9 map the distribution in India as verified by this survey.

Geographic Variation: Two subspecies (one new) are recognized herein.

Kachuga smithii pallidipes subsp. nov.

Pale-footed Roofed Terrapin — Pl. III, B&C

Holotype: Field Museum Natural History 224177, adult male in alcohol; collected in the Gandak River, Bherihari Wildlife Sanctuary, Bettiah (West Champaran) District, Bihar on 3 June 1983; original number 2827 Edward O. Moll.

Paratypes: USNM 257779, adult female in alcohol; Karnali River, Royal Bardia Wildlife Reserve, 2 km N. Thakurdara, Nepal, 23 April 1985 (obtained by Joseph Mitchell); FMNH 224186, adult female skeleton, Ghagra River, near Kailaspuri at Girija Barage, Bahraich District, Uttar Pradesh, 12 January 1983.

Identification: A subspecies of *Kachuga smithii* differing from the nominate form by the absence of a plastral pattern and a reduction of pigment on head, limbs, feet and penis.

Description of holotype: An adult male measuring 8.6 CL, 6.2 CW, 7.8 PL, 3.1 H and weighing 88 g. Coloration in life — carapace light grayish olive to brownish olive (older scutes) with pale yellow rim around the periphery; single mid-saggital black stripe with cinnamon-rufous center on Vertebrals 2 and 3, running length of the shell but becoming obscure on V5 and 6; plastron straw yellow, immaculate, having no dark pattern; vague dark blotches present on ventral side of marginals.

Head brownish olive, lightly mottled with smoke gray dorsally; skin creamy white behind eyes; iris pale gray; throat immaculate, colorless; a pair of narrow dark stripes extend anteriorly from eyes converging to meet at light gray snout; mandibles bright spectrum yellow; neck smoke gray dorsally, colorless ventrally, unstriped.

Limbs — ground color on leading face of front limb smoke gray above elbow and lateral half of foreleg; large triangular scales on lateral border of foreleg, narrow bandlike scales on anterior aspect; toes and webbing yellow; posterior aspect of limb, feet and medial half of foreleg colorless.

Penis colorless lacking the dark pigment characteristic of most members of the order.

Description of Paratypes: USNM 257779, adult female measuring 15.6 CL 11.6 CW 15.5 PL 5.65 H and weighing .453 kg. Coloration of preserved specimen — carapace brownish gray with a black, middorsal stripe; plastron light, largely devoid of pattern but tiny smudges of pigment present near posterior lateral margins of scutes; bridge and ventral side of Marginals 3-9 with heavy concentrations of dark pigment.

Head and neck dark grayish brown dorsally with lighter cinnamon brown band running posteriorly from eye over tympanum; throat light, colorless.

Limbs — anterior face of forelimb and feet generally grayish brown, becoming lighter on medial aspect; lateral border of limb light edged; hind feet immaculate, devoid of pigmentation; skin of leading face of hind leg grayish brown.

FMNH 224186, female measuring 16.2 CL 11.6 CW 15.5 PL 6.0 H and weighing 0.63 kg. Coloration in life — carapace buff with dark brown middorsal stripe; plastron straw yellow, unpatterned.

Head and neck drab dorsally with lighter, cinnamon-colored band running posteriorly from eye over tympanum; tip of snout and iris light grayish blue; mandibles light orange yellow; neck dirty gray above, light cream ventrally.

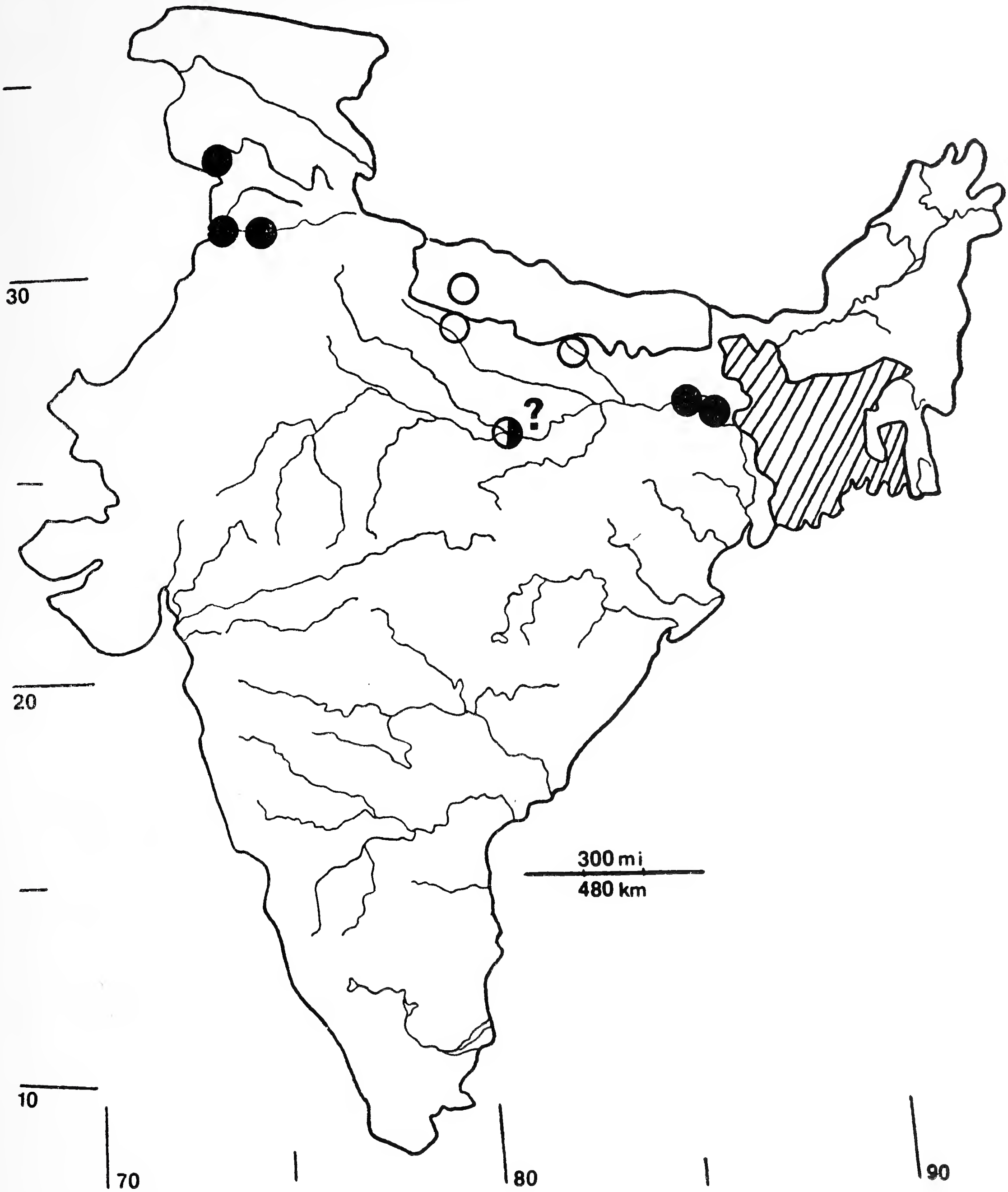


Fig. 9. Distribution map of *Kachuga smithii* in India (see legend of Fig. 7). Solid circles indicate localities of the nominate race, *K. s. smithii.* Open circles indicate localities of *K. s. pallidipes.* The half open circle indicates Allahabad, a possible intergrade site between the two races (see text).

Limbs with toes and skin flap at lateral edge of hind foot immaculate, devoid of pigment, otherwise outer leading surface of fore and hind legs gray; trailing surface of legs creamy white.

Distribution: The three members of the type series of this subspecies come from northern tributaries of the Ganges. See Figure 9 and comments on intergradation under remarks.

Natural History: Little is known about the natural history of this form. All three records were associated with riverine environments. The holotype was collected during the day in a hoop trap baited with fish set near a sand bank in the Gandak River. The Nepal specimen was collected by hand under a pile of sticks and debris in a pool on the floodplain of the Karnali River. The other female was taken by a fisherman in the Ghagra River but details are lacking. Remains of a freshwater prawn were found in the gut of the latter specimen.

Remarks: Presently it seems best to regard this taxon as a subspecies of *K. smithii* rather than as a distinct species for the following reasons. 1) The male from the Gandak River has been selected as the holotype or best representative of this race. The two female paratypes from more westerly drainages show some characteristics of the nominate form (more dark pigment on the head, limbs and ventral part of shell) suggesting intergradation. One of the original types used by Gray (1863) in the species description from the Chenab River in northwestern India (BMNH 63.2.21.87) lacks pigmentation on the pectoral scutes and only small amounts are present on the abdominals. This too could represent intergradation. More collections are needed to confirm whether the observed variation has resulted from intergradation rather than some other factor such as sexual dichromatism. 2) A precedent exists for this type of variation in a related species. In what appears to be a case of unusual parallelism, populations of *Kachuga tentoria* from northern tributaries of the Ganges also exhibit a reduction of dark pigment and have no plastral pattern. More collections are available for this species and intergradation is evident in the more western drainages of the Ganges (see *K. tentoria*).

A peculiar situation exists with a series of specimens from Allahabad in Uttar Pradesh. The Zoological Survey of India collection has five specimens of *K. smithii* from this locality. Three reportedly have the dark plastral pattern (ZSI 457, 471, 472) and two do not [ZSI 451, 200 (1912)]. Another specimen in the British Museum (BMNH 1908.12.28.2) from this locality has dark blotches only on the anal scutes. Whether these specimens were actually obtained in Allahabad or whether they were obtained elsewhere and shipped to markets there is not known. Neither is there any information on the coloration of the rest of the body in this collection. The entire problem requires additional study.

Kachuga smithii smithii (Gray 1863)

Brown Roofed Terrapin — Plate III, A

Identification: A subspecies of *K. smithii* having a plastral pattern of large dark brown to black blotches on each scute narrowly bordered with yellow; sides of head, leading surface of limbs, feet and penis dark pigmented.

Description: Female (FMNH 224143); carapace brownish olive bearing a middorsal dark brown stripe; a small dark triangle decks areolar portion of Pleurals 2 & 3 and vertical dark bars border seams between the more posterior marginal scutes and the posterior edge of Pleural 4; plastron, bridge and ventral side of marginal chiefly dark but narrowly bor-

dered with light yellow; head and neck olive dorsally; a tawny blotch present behind eye; vague striping evident on lateral portion of neck; iris pale blue-gray; mandibles deep buff yellow; skin on outer surface of limbs olive with bandlike scales on forelegs appreciably lighter than ground color; vague striping present on hind legs and rump.

Size and Sexual Dimorphism: Minton (1966) reported that eight females and three males from Pakistan ranged from 15.3-22.7 CL and 10.1-10.8 CL respectively. Smith (1931) recorded the largest specimen as 23.0 CL 15.5 CW and 8.5 H. This race was rarely encountered on our survey. Six shells found in garbage dumps near Rajmahal, Bihar ranged from 13.2 to 18.3 (mean 15.7) CL. A subadult female obtained from fishermen at Kahalgaon, Bihar measured 14.3 CL 10.3 CW 13.7 PL 5.9 H and weighed 0.315 kg.

Males differ from females by being considerably smaller and by having a longer tail which is heavier at the base. Minton (1966) states that the tail of males projects free about 10 per cent of the carapace length whereas that of the female is about 5 per cent.

Natural History: Brown roofed terrapins are typically associated with rivers and occur in current as well as more lentic habitats such as backwaters. Minton (1966) found them to be a social basking species on the Indus where they undergo a period of quiescence from early December to early March. He reported finding females with eggs in early October; a clutch of seven laid by a captive contained eggs 43 to 45 mm long and 22 to 24 mm wide. Chaudhuri (1912) reported that five to eight eggs are buried in sand nests but gave no season. Ewert (1979) reported the mean size of four hatchlings to be 3.92 CL and 3.67 PL. The species is generally reported to be omnivorous with a carnivorous bias (Das 1985, Minton 1966, Smith 1931). Gut contents of the subadult female from Kahalgaon contained only plant material.

Distribution: The brown roofed terrapin has been reported from the Indus, Ganges and Brahmaputra Drainages of Pakistan, India and Bangladesh. The Museum d'Histoire Naturelle in Geneve, Switzerland has specimens catalogued as *K. smithii* from Assam but I have not examined these. Minton (1966) found the turtle to be common in the Indus Drainage while Smith (1931) considered it to be much rarer in the Ganges Drainage. Reza Khan (1982) also reported that the species is uncommon in Bangladesh. The species was rarely encountered on our survey. Figure 9 maps localities verified for India.

Specimens were collected from the following sites:

FMNH 224143 — Ganges River, Kahalgaon, *c.* 50 km W. Sahibganj, Bhagalpur District, Bihar.
EOM 2720-2725 — Ganges River, Rajmahal, Dumka (Santhal Parghana) District, Bihar.

Type locality of this race is "Northwestern India: Punjab; "River Chenab..." Syntypes are BMNH 1947.3.4.69-70. Much of the former Punjab is now part of Pakistan and most of the Chenab River now found in India is in Jammu and Kashmir rather than the state of Punjab. Hence the type locality could well be Pakistan. The dot on figure 9 is the western-most point of the Chenab in India. Other preserved specimens verified include:

MCZ 3233 — Ludhiana, Punjab.
ZSI 17606 — Firozpur, Punjab.

Kachuga sylhetensis (Jerdon 1870)
Assam Roofed Terrapin

Identification: A small terrapin (20 cm CL) differing from other *Pangshura* by typically having 13 pairs of marginal scutes and

a fifth vertebral scute that is wider in the anterior half than in the posterior.

Description: Head medium-sized with slightly projecting snout; upper jaw slightly hooked with serrations along the tomium being fine or absent; head patterned with a pair of narrow yellow stripes running posteriorly from eye to meet at mid-line on back of head forming a chevron; an additional light stripe runs along underside of the mandible curving upward to meet tympanum; neck with light longitudinal stripes.

Shell steeply peaked as in *K. tecta* and *tentoria* but more serrate posteriorly; oval in shape being widest across plane through sixth marginals; median keel relatively narrow on first through third vertebrals; sharp pointed spines present on the third (largest) and fourth vertebrals; Vertebrals 3 and 4 longer than broad, V2 and 5 broader than long and V1 either as wide or somewhat wider than long; scute contact formula: 1M 4> 6> 8M 11<; coloration of preserved specimens olive-brown with a lighter vertebral keel. Plastron oval with slight notch or no notch between anals; plastral formula F >< Ab > P > H > A > G; inguinal and axillary scutes well developed; pattern a large dark blotch on each plastral scute, bridge, and ventral side of marginals.

Size and Sexual Dimorphism: As typical for the genus, males are much smaller than the females. The largest specimen recorded is a female 19.7 cm CL (Jerdon 1870). Measurements of a typical male and female are:

BMNH 1929.11.21.1 M — 8.5 CL 6.8 CW 8.0 PL 4.7 H

BMNH 1947.3.4.22 F — 18.3 CL 14.3 CW 17.8 PL 8.4 H

In addition to being smaller, males have longer tails which are thicker at the base than those of females.

Natural History: Most specimens have come from hill streams; nothing else seems to be known of the natural history.

Distribution: The Assam roofed terrapin has been reported from the Khasi, Garo and Naga Hill areas of Bangladesh and Assam. As these areas were off limits to our survey, no living specimens of this species were seen or collected. I have examined museum specimens from the following localities:

BMNH 1947.3.4.22 (type) — Khasi Hills, Sylhet District, Bangladesh.
BMNH 1929.11.21.1 — Khasi Hills, Cherrapunji, Meghalaya, India.
ZSI 110 — Cachar District, Assam, India.
ZSI 3923 — Garo Hills, Assam, India.

Kachuga tecta (Gray 1831b)
Indian Roofed Terrapin — Plate III, D-F

Identification: A small *Pangshura* (23 cm CL) with a high vaulted shell (height/length > 45%) most easily distinguished from its closest relative, *K. tentoria,* by its pattern and brighter coloration. Plastral pattern of small dark blotches or streaks (1-4) on most scutes; head with a large red to orange crescent-shaped blotch behind eye; neck with bright yellow stripes and limbs bearing bright yellow spots. Smith (1931) used as a key character that the second vertebral is longer than the third in *tecta* but not in *tentoria.* Although useful, this character is variable being correct in only 76 percent of the 21 *K. tecta* and only 63 percent of the 45 *K. tentoria* examined.

Description: Sexes colored similarly (live female, Lucknow, U.P.); carapace raw umber (brown) with somewhat lighter middorsal stripe (can also be red) bordered in black and a narrow yellow border on marginals; plastron buff-yellow with 2-4 small, round to elongate. black markings on scutes other than gulars and/or anals which may have only one; two dark spots on bridge, one each on inguinal and axillary scutes and on underside of each

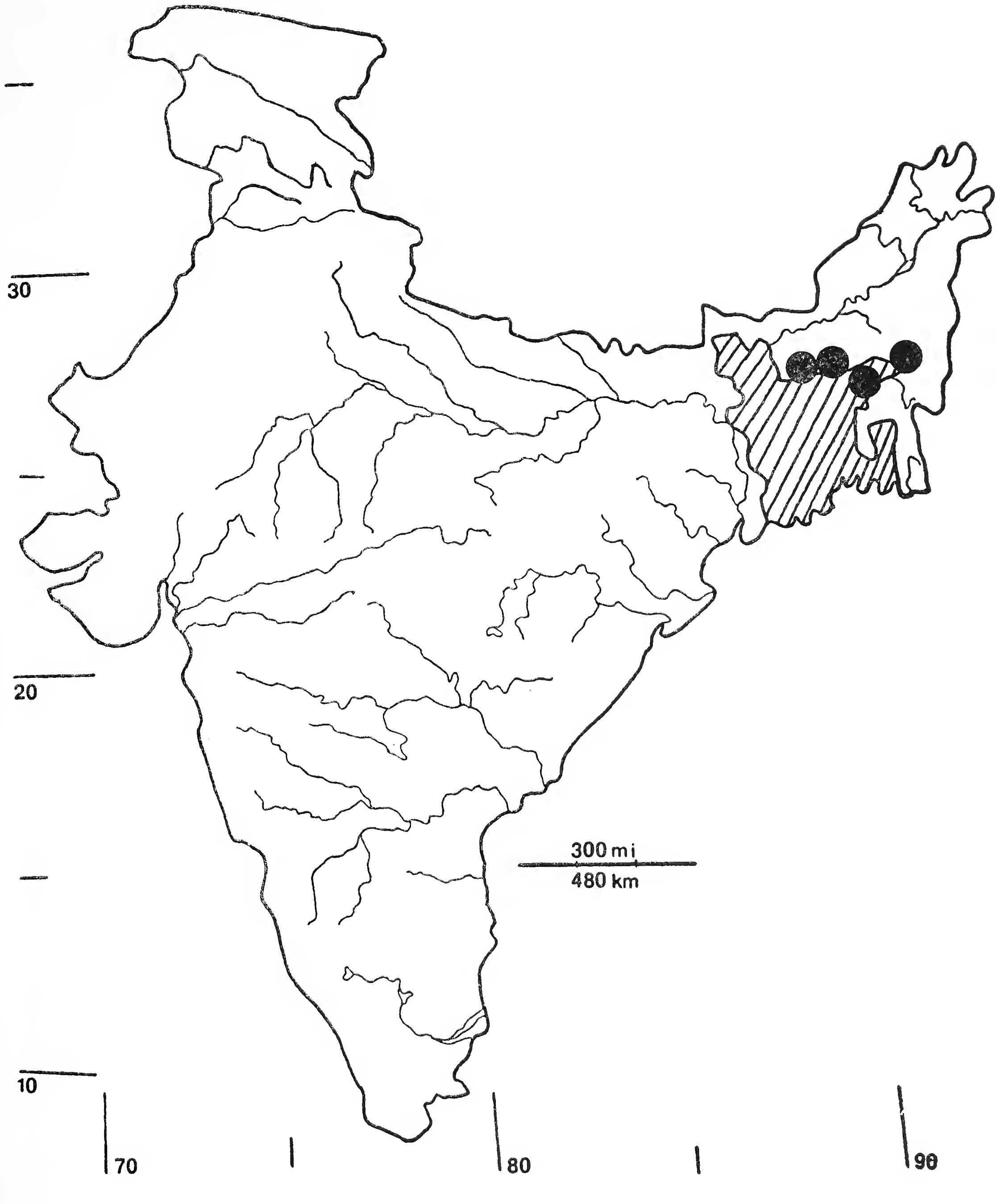


Fig. 10. Distribution of *Kachuga sylhetensis* (see legend of Fig. 7).

marginal; head dark with large orange yellow to spectrum orange crescent-shaped, post-ocular blotch curving upward from below eye and extending obliquely across head to meet and form chevron with blotch from opposite side; iris dark; mandible orange yellow becoming orange beneath snout; neck dark, patterned with yellow stripes being brightest laterally and ventrally; outer surface of limbs dark, studded with bright orange yellow spots on scales; rump with vertical orange yellow stripes on lighter background.

Shell oval, steeply pitched, widest at plane through sixth or seventh marginals, posterior edge slightly serrate; middorsal keel widest on first three vertebrals, a prominent pointed spine present on Vertebral 3; V1 widest in anterior half, usually as long or slightly longer than wide; V4 flask-shaped, much longer than wide; V5 widest in posterior half and wider than long; V2 and 3 vary in length-width relationships; scute contact formula — 1> 4M 6M 8M 10M. Plastron truncate anteriorly and notched posteriorly; anterior lobe shorter than posterior, both shorter than bridge; plastral formula-Ab >< F > H> A> P> G; axillary and inguinal scutes large, subequal in length.

Head moderate; snout shorter than orbit; skin at back of head divided into a series of irregular scales; secondary palate broad with single denticulate ridge; edge of tomium coarsely serrate and lacking medial notch. Lower mandible ending in prominent medial tooth; alveolar surface concave except for a serrate ridge along lingual border which joins a symphyseal ridge at midline; moderate coronoid process present. Hyoid moderately developed; ossified portion comprising a single-unit, elongated body with a broad shallow notch posteriorly and a deeper, narrower notch anteriorly; a narrow, curving, elongated pair of first branchial horns and a pair of small kidney-shaped second branchial horns.

Size and Sexual Dimorphism: Females are much larger than males. The largest specimen recorded is 23 cm CL (Smith 1931). Minton (1966) reported two adult females and a male from Pakistan measured 16.4, 17.3 and 8.4 cm CL. Measurements of two females and one male examined in this survey are:

Live F — 15.3 CL 11.5 CW 14.7 PL 7.3 H weight 0.51 kg.

EOM 2784 (BNHS uncataloged) F — 18.3 CL 14.2 CW 17.2 PL 7.3 H weight 0.96 kg.

Live M (mature?) — 6.6 CL 5.4 CW 6.3 PL 3.7 H weight 0.054 kg.

In addition to size males differ from females by having a longer, thicker tail in which the vent opens beyond the carapacial rim.

Hatchlings: Four hatchlings from eggs laid by a female at Lucknow, Uttar Pradesh averaged 3.15 CL 2.8 CW 2.8 PL 1.8 H and 7 grams weight. Young *K. tecta* are strikingly attractive turtles. The carapace is bright lime green rimmed with a yellow orange border. There is a broken middorsal stripe of flame scarlet bordered in black and each pleural has a tiny black spot at the posterior dorsal edge where a lateral keel would be. The plastron is chrome orange patterned with small, irregular, black blotches on each scute including the axillary, inguinal and underside of the marginals. The head and neck are dark olive in ground color with the latter decked with bright yellow stripes. A large crescent-shaped flame scarlet blotch begins under the eye, curves upward behind the eye and meets its counter part from the opposite side at the back of the head forming a "V" shaped figure. A small flame scarlet spot marks the posterior of each eye lid. The scales of the limbs as well as the webbing between the toes are bright yellow on a dark olive background.

Natural History: Indian roofed terrapins chiefly inhabit lentic habitats (tanks, nullahs and backwaters) in the Ganges and Indus drainages. Slow moving or quiet vegetation-choked waters appear optimal. We observed this species in a weedy backwater of the Ghagra River, a small impoundment pond near Lucknow, U.P. and in a slow moving nullah crammed with aquatic vegetation which flowed into a nearby ox bow lake in the Udaipur Forest Area of Bihar. Khan (1982) reported *K. tecta* occupying flowing and stagnant waters in Bangladesh. In the Narmada River where *K. tentoria* and *K. smithii* are seemingly absent, we found *K. tecta* to be moderately common.

Like its close relative the Indian tent terrapin, the Indian roofed terrapin is commonly seen basking on logs or the river bank. Parshad reported that it is herbivorous (Smith 1931). However, we caught one specimen in a hoop trap baited with chicken entrails.

A specimen from Lucknow laid a clutch of eight eggs on January 13. The eggs averaged 37 x 21 mm and 10.75 grams. Relative to the female reproductive efforts, calculations are: RCM — 0.21, EMI — 2.1, ELI — 24.2 and EWI — 14.

Distribution: The Indian roofed terrapin definitely occurs in the Indus, Narmada, Ganges and Brahmaputra River Systems of Pakistan, India and Bangladesh. Based on the Indian distribution, it probably occurs in Nepal as well. A series of specimens in the Museum of Comparative Zoology (MCZ 3459, 3460, and 3462) labelled Rangoon, if verified would extend the range much farther East. Figure 11 depicts the distribution in India as verified by the survey:

Live F — Kukrail, nr. Lucknow, Lucknow District, India.
Live M — Harhi Nala, 15 km W Bettiah, Bettiah Dist., Bihar.
EOM 2658 — 6 km S Katarnia Ghat, nr. Girija Barage, Bahraich District, U.P.
EOM 2868 — Bedaulia, Manika, Muzaffarpur District, Bihar.
EOM 2784 (uncataloged specimen BNHS) — Narmada River, Dhavdi Ghat, nr. Punasa, East Nimar District, M.P.

In addition the following preserved specimens have been examined and verified :

BNHS 1290-1291 — Chandola Lake, nr. Ahmedabad, Ahmedabad District, Gujarat.
ZSI 17609 — Makhu, Firozpur District, Punjab.
ZSI 21672 — Magwall Village, Jammu District, Jammu-Kashmir.
Uncatalogued specimens BNHS — Hindon River, Mohen Nagar, nr. Ghaziabad, Meerut District, U.P.
ZSI 18015 — Baradighi Tea Estate, Jalpaiguri District, West Bengal.
ZSI 19236 — Cherrapunji, Meghalaya, India.

Remarks: The Indian roofed terrapin is the only *Kachuga* to be listed on CITES (Appendix I) or the Indian Wildlife (Protection) Act (Schedule I). Reasons for listing are obscure; we found the species to be relatively common in the aforementioned sites and it did not appear to be a popular market species. Khan (1982) judged it to be the most common turtle in Bangladesh. Nevertheless because of the turtle's status, the aforementioned preserved specimens were either taken as shells or in the case of EOM 2784, a turtle which drowned in a fisherman's net. All specimens from the survey were left within the country.

Kachuga tentoria (Gray 1834)

Indian Tent Terrapin — Plate II

Identification: A moderate-sized *Pangshura* (27.1 cm CL) with a high, vaulted shell (height/length > 45%); differing from *K. tecta* by having one or two small reddish to brownish spots behind the eye instead of a broad crescentic band and by having a plastron with a single large dark blotch per scute or lacking in dark markings.

Description: Shell oval being widest at a

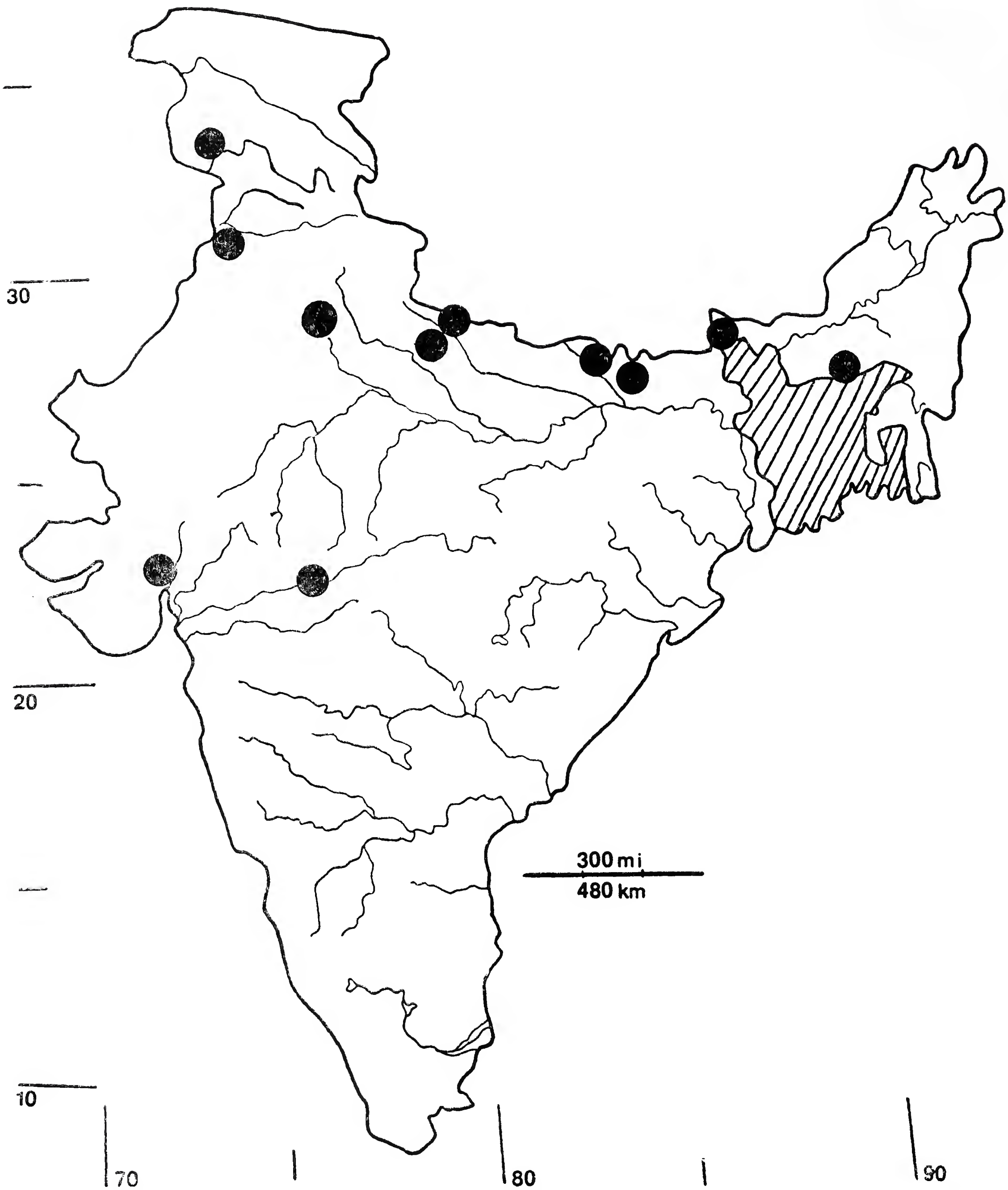
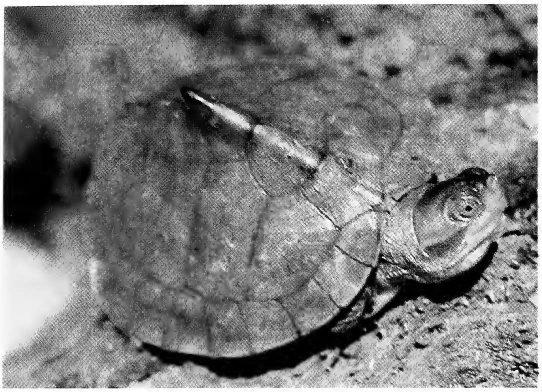
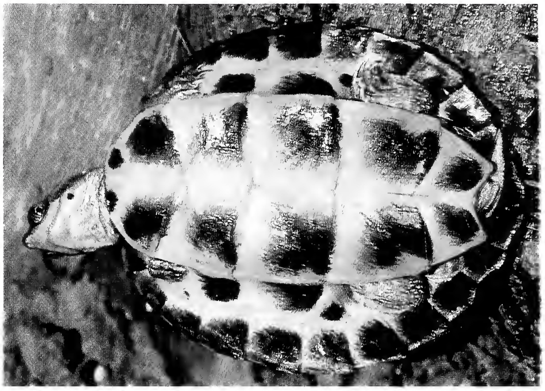


Fig. 11. Distribution of *Kachuga tecta* in India (see legend of Fig. 7).



A



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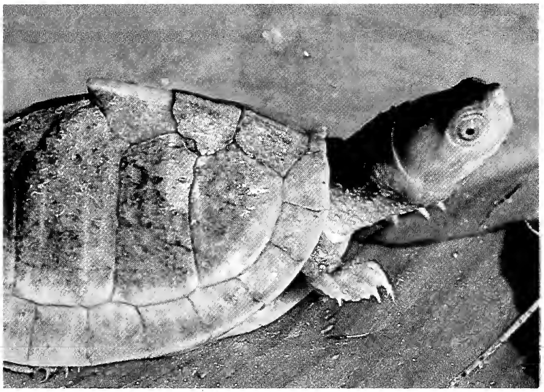

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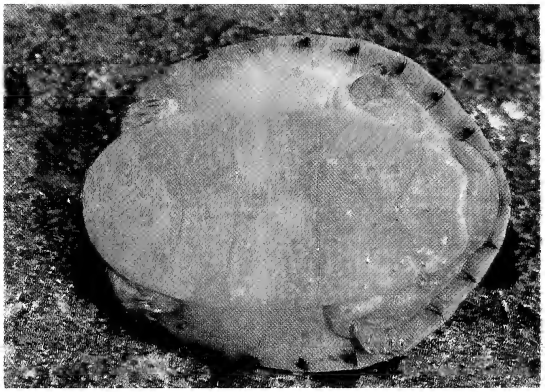

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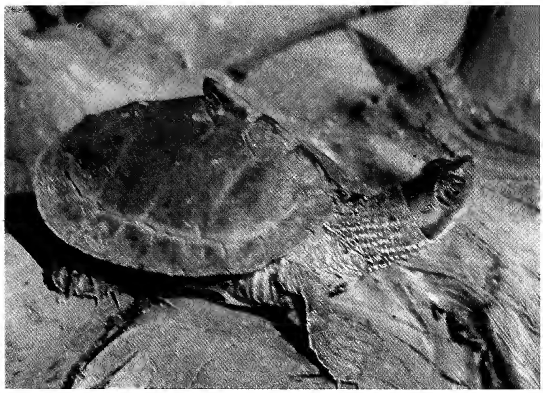
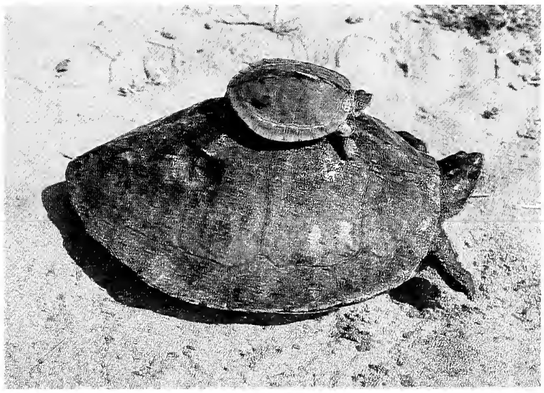


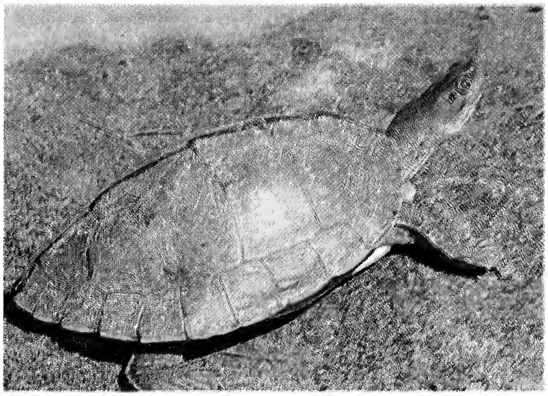
E



F

(A) *Kachuga tentoria tentoria* — Juvenile (8.1 cm CL) from the Godavari River near Manthani, A.P. (B) *Kachuga t. tentoria* — Ventral view of A. (C) *K. t. flaviventer* — Male (8.3 cm CL) from the Gandak River, Bettiah District, Bihar. (D) *K. t. flaviventer* — Ventral view of C. (E) *K. t. circumdata* — Male (8.5 cm CL) from the Yamuna River nr. Etawah. (F) *K. t. circumdata* — Male (8.1 cm CL) and female (23.5 cm CL) from the Yamuna River near Etawah.

PLATE III



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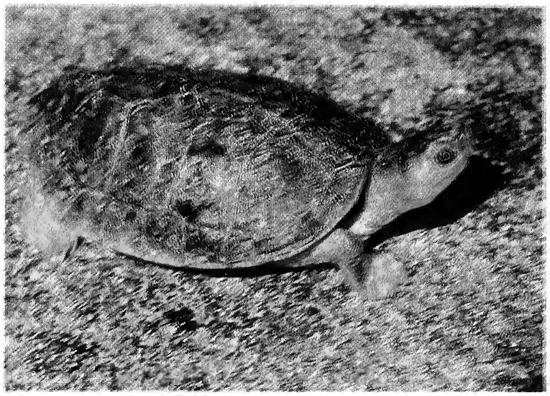

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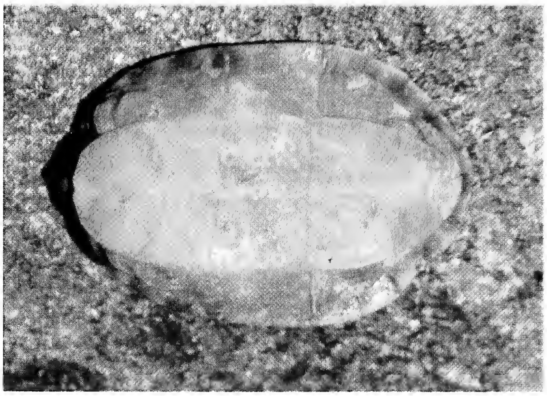

C

D

E

F

(A) *Kachuga smithi smithi* — Female (14.2 cm CL) from the Ganges near Kahalgaon, Bihar. (B) *K. smithi* subsp. nov. — Male (8.6 cm CL) from the Gandak River, Bettiah District, Bihar. (C) *K. smithi* subsp. nov. — Ventral view of B. (D) *K. tecta* — Immature female (6.4 cm CL) from near Bettiah, Bihar. (E) *K. tecta* — Hatchling (3.0 cm CL) from Lucknow, U.P. (F) *K. tecta* — Ventral view of E.

plane passing through the seventh marginals; a prominent middorsal keel runs the length of the carapace breaking at the end of each vertebral to form a knob or spine, the most pronounced being a sharp upward projecting spine on V3; in adults Vertebrals 3 and 4 typically longer than wide with 5 being wider than long; V1 and 2 variable, with 1 often being hour glass or bell shaped (pinched in the middle) in large individuals; seam contact formula — 1> 4> 6M 8M 10M. Plastron truncate anteriorly, notched posteriorly; plastral formula — AB > F > P > H > A > G; bridge long exceeding lengths of both the shorter fore lobe and longer hind lobe of plastron; axillary somewhat smaller than inguinal scute. Cloacal bursae present with pronounced villous lining.

Head medium-sized with short, pointed, projecting snout; skin at back of head divided to form a series of irregular-shaped scales; upper jaw serrate lacking median notch or prominent projections; alveolar surface broad, bearing single "V" shaped denticulate ridge. Lower jaw similarly serrate with single, prominent, projecting tooth at apex; lower alveolar surface concave bordered by serrate ridge along lingual surface meeting a short symphyseal ridge at midline. Hyoid moderately developed with ossified portions including a single-element body having a prominent rounded notch posteriorly and a smaller "V" shaped notch anteriorly, a pair of thin, elongate, outwardly bowed first ceratobranchial horns and a pair of small, rounded second ceratobranchial horns.

Distribution: The Indian tent terrapin is restricted to drainages of rivers flowing into the Bay of Bengal in India, Nepal and Bangladesh. Figure 12 depicts the distribution in India as verified by the survey.

Remarks: Until recently *K. tentoria* has been considered a subspecies of *K. tecta.* However, as both appear to be sympatric over a broad geographic area including Bangladesh (Khan 1982), Bihar, and Uttar Pradesh (this paper); herein I follow Pritchard (1979) in regarding them as separate species pending additional study. Smith (1931) lists the type locality for *K. tentoria* as Dhond (Krishna River Drainage), Poona District of Maharashtra. See Mertens (1969) for a history of the nomenclature of these two species.

Three subspecies of *K. tentoria* (one resurrected) are recognized herein — *Kachuga t. tentoria* in the rivers of peninsular India; *K. t. circumdata* in the western and central drainage of the Ganges and *K. t. flaviventer* in the eastern Ganges and its northern tributaries.

Kachuga tentoria tentoria (Gray 1834)

Indian Tent Terrapin — Plate II, A+B

Identification: A race with a dark plastral pattern, no pleuro-marginal ring and reddish head markings.

Description: Sexes colored similarly (FMNH 224163 juv., Godavari River); carapace antique brown, unicolor except for hazel to amber stripe along middorsal keel from Vertebrals 1-3; plastron yellow with large dark blotches on each scute, bridge, axillary, inguinal and underside of marginals; ground color of head olive to brownish olive; a poorly defined clay band present behind eye; red markings include a small red postocular spot in clay band, a smaller red mark located at dorsal posterior edge of eye and a thin poorly defined red line in occipital region; iris gray olive; mandibles straw yellow; neck with dull straw yellow stripes on lateral and ventral portions; limbs olive with edges of scutes cream; rump marked with vertical black and cream stripes.

Size and Sexual Dimorphism: Males are much smaller than females. Three males from the Mahanadi River measured 8.1, 9.7 and

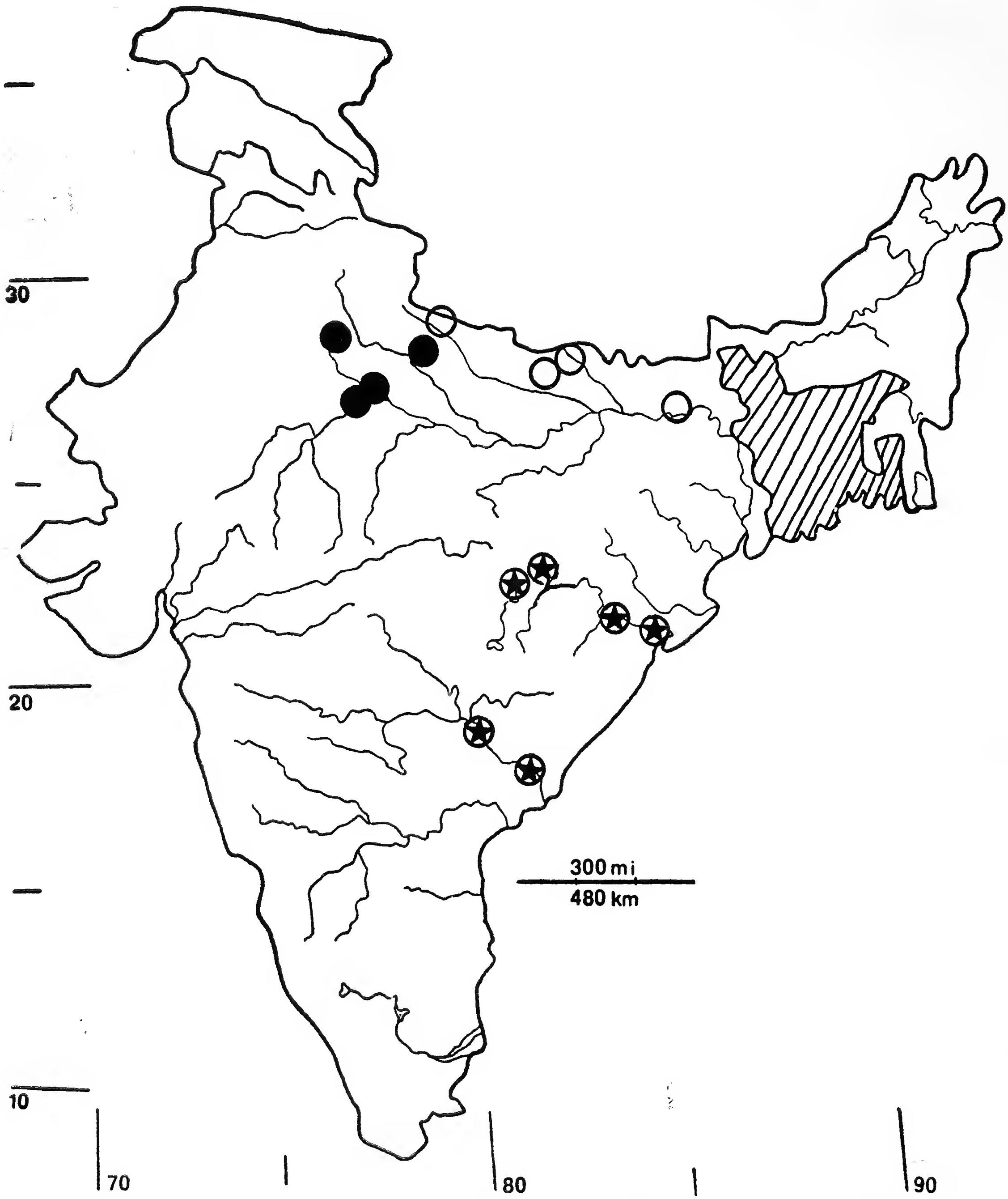

Fig. 12. Distribution of *Kachuga tentoria* in India (see legend of Fig. 7). Starred circles indicate localities of the nominate race, *K. t. tentoria.* Solid circles indicate localities for *K. t. circumdata.* Open circles indicate localities for *K. t. flaviventer.*

10.9 cm CL. Another 7.5 cm CL with no sperm in the epididymides was judged subadult. Six females from this locality ranged from 19.2 to 23.0 (mean 20) cm CL. Two other females 18.5 and 18.0 cm CL with no enlarged follicles on their ovary and relatively small oviducts were judged subadult.

Proportions of a typical male and female of this race follow:

BNHS 1329 F — 19.5 CL 14.2 CW 18.9 PL 8.9 H weight 0.86 kg.

FMNH 224141 M — 9.7 CL 7.5 CW 9.2 PL 4.6 H weighing 0.105 kg.

In addition to size, males differ from females by having a longer (preanal > postanal) and thicker preanal portion of the tail with a vent opening beyond the edge of the carapace.

Natural History: Indian tent terrapins occur in small to large rivers of peninsular India. They are frequently seen on logs and rocks basking. Females appear completely herbivorous. They never entered hoop traps baited with chicken entrails or fish and other than a small feather, the guts of four individuals from the Mahanadi River contained only leaves and stems of vascular plants. Males and juveniles appear more omnivorous. They did enter baited hoop traps and the stomach of one male examined contained 75 percent vegetation and a fresh water prawn. Ovaries of two females collected on the Mahanadi River in mid-February appeared post-reproductive having few enlarged follicles and several small, old corpora lutea.

Distribution: *Kachuga t. tentoria* ranges from at least the Mahanadi River drainage southward to the Krishna drainage. The turtle was taken at the following localities on the survey:

FMNH 224163 — Godavari River, Manthani, Karimnagar Dist., A.P.

Live Juvenile — Godavari River, Polavaram, West Godavari Dist., A.P.

FMNH 224141, BNHS 1329 — Mahanadi River, Tikarpura, Dhenkanal, Orissa.

The following additional records have been verified from preserved collections:

ZSI (Type *Kachuga t. intermedia* Blanford 1870) — Hasdo River, Bilaspur Dist., M.P.

ZSI 17775 — Seonath River, Bilaspur, Bilaspur Dist., M.P.

ZSI 16767 & 68 — Mahanadi River, Cuttack, Cuttack Dist., Orissa.

Kachuga tentoria flaviventer (Gunther 1864)
Plain-bellied Tent Terrapin — Plate II, C & D

Identification: A small tent terrapin (20.3 cm CL) with reduced pigmentation, an unpatterned plastron and little or no striping on neck and rump.

Description: Sexes colored similarly. Male (FMNH 224178) — carapace brownish olive; light middorsal stripe with pale orange wash on Vertebrals 1 and 2, cream on V3, becoming faint on V4 and 5; pleuro-marginal juncture and border of shell also cream; plastron, bridge and underside of marginals cream and unpatterned; head pale, mottled with brownish olive; a near colorless patch washed with pale salmon extending from behind eye back over mastication musculature to meet patch from opposite side; immediately posterior a dark horizontal line marks juncture of head and neck; neck colorless to pale cream; a small irregular splotch of cinnamon rufous occurs in colorless area immediately behind eye; iris light smoke gray; limbs almost colorless except for a scattering of dark pigment along leading face; webbing and underside of feet creamy.

Female (FMNH 224132) colored as above with the following exceptions: carapace light buff or cinnamon ground color; the central stripe being a darker, tawny coloration with a lighter center; plastron unpatterned but dark blotches present on underside of marginals; head smoke gray dorsally, cream laterally and on mandibles; a light cinnamon-brown spot

behind eye and another at posterior dorsal edge of eye; three additional spots at posterior of head (one medial flanked by two lateral); webbing of feet pale yellow.

Size and Sexual Dimorphism: Sexes widely disparate in size. A female and two shells presumed to be female from Kahalgaon measured 16.5, 16.9 and 18.8 CL. Five males from the Gandak River in northwestern Bihar showing well developed secondary sex characters ranged from 6.6 to 8.8 (mean 8.0) CL. Measurements of two typical specimens are:

FMNH 224132 F — 16.5 CL 12.4 CW 16.1 PL 7.9 H weight 0.64 kg.

FMNH 224178 M — 8.2 CL 6.3 CW 7.7 PL 4.1 H weighing 0.09 kg.

In addition to size males differ from females by having a longer tail (preanal > postanal portion) which is relatively thicker at the base.

Hatchlings: Vijaya (1982e) provided mean measurements for hatchlings from six clutches of the pale-bellied tent terrapin (see comments under geographic variation) laid in nests along the Rapti River near Gorakhpur, U.P. Largest and smallest of these means were: Clutch I — 2.7 CL 1.7 CW 2.3 PL 1.6 H and 6.5 g weight. Clutch V — 3.35 CL 2.7 CW 3.1 PL 1.8 H and 10 g weight. Shell coloration — carapace mottled light and dark olive with a light yellow stripe along the middorsal keel; pleuro-marginal ring light geranium pink at hatching fading in the first few months to a pale olive; plastron buff yellow and unmarked; underside of marginals with a pepper like dusting of dark pigment; head ground color pale olive; two flesh pink spots located posterior to eye and at posterior of eyelid respectively and a narrow, flesh pink bar, broken in the middle, at back of head; vague striping discernible on neck and rump.

Twelve hatchlings obtained from three clutches of eggs collected at the Katarniaghat Gharial Sanctuary in U.P. had the following mean dimensions: 3.55 CL 3.23 CW 3.2 PL 2.0 H and 9.0 g weight. Their shells were slightly serrate posteriorly with carapacial spines being very small except for a prominent projection on V3. V1 was broadest anteriorly lacking the pinched bell-shape of large adults. None had a plastral pattern but varied as to the presence of dark pigment on the underside of the marginals. Amounts varied from none to having a dark blotch on each scute. Another variable feature was the amount of red in the pattern. Some had an extensive amount including a geranium pink pleuromarginal ring, middorsal stripe and head pattern. Concerning the latter at one extreme some individuals had both a transverse pink line across the back of the head, two pink spots at the snout and a postocular, pinkish crescent behind the eye. The crescent (similar to that of *K. tecta* but less extensive) was formed by an elongation of the postocular spot to meet the elongated one at the rear of the eyelid (this was evident in other individuals in which the merger was incomplete). At the other extreme were individuals with no pink whatsoever; the pink areas of other individuals were colorless.

Natural History: Like the other races of this species the pale-bellied tent terrapin appears to be chiefly a river turtle. We found this race in Katarniaghat Gharial Sanctuary, an impoundment of the Ghagra River, but otherwise all were seen or collected in areas of flowing water. Many were observed basking near the bank in a sandy area of the Gandak River in May. Gut contents of one male and one female examined contained only leaves and stems of aquatic vegetation. However, five males were taken in traps baited with chicken entrails and fish suggesting that they may be somewhat omnivorous.

Vijaya (1982e) found nests of this turtle

in "soft, clayey river bank soil" along the Rapti River near Gorakhpur from 6-8 December. Nests varied from 15 to 26 cm in depth and were located 3 to 14 metres from the water. Six nests contained from 4 to 8 (mean 6) eggs per nest. She provided mean egg sizes for each nest ranging from 41 x 29 mm and 11.7 g to 45 x 27 mm and 18.5 g. Incubation times (time to emergence from substrate?) in artificial nests ranged from 125 to 134 days at nest temperatures varying between 27° and 28°C.

On this survey we found three clutches comprising 6, 7, and 10 eggs in nests made by this turtle in sand banks along the Ghagra River in the Katarniaghat Gharial Sanctuary on December 5. Mean size of the eggs was 42 × 25 mm and 15.3 g weight. Mean incubation time for 12 hatchlings (to emergence from egg) was 95 days from eggs kept on moist cotton in plastic boxes at ambient temperatures ranging from 24° to 33°C.

Distribution: The pale-bellied tent terrapin inhabits the northern tributaries of the Ganges and possibly the Ganges proper from Bihar eastward. So far I have examined no specimens from West Bengal or Bangladesh. Specimens collected on the survey are from the following localities.

FMNH 224142 — Katarniaghat Gharial Sanctuary, Ghagra River, Bahraich Dist., U.P.

Hatchlings (Vijaya 1982e) — Rapti River, nr. Gorakhpur, Gorakhpur Dist., U.P.

BNHS 1339 & FMNH 224178 — Gandak River, Bherihari Wildlife Sanctuary, Bettiah (West Champaran) Dist., Bihar.

FMNH 224132 — Confluence of Kosi and Ganges River, Khalgaon, *c.* 50 km W Sahibganj, Bhagalpur Dist., Bihar.

Remarks: Gunther (1864) recognized this taxon as distinct and described it as a new species *Pangshura flaviventer*. The description was based on a single specimen presumed to be from India but lacking in precise locality data. It had been collected by a Mr. McClelland who had also sent several other specimens of Bengal species. Subsequent authors (e.g. Boulenger 1889, Smith 1931) considered it a variant of *Kachuga tecta*. Now that more specimens have been found, it is evident that this is a legitimate taxon. However, it appears to be a subspecies of *Kachuga tentoria* rather than a separate species. Evidence for this comes from the aforementioned hatchlings examined from the Rapti and Ghagra Rivers. Characteristics of these specimens particularly those from the Ghagra River appear to be intergrading with those of *K. tentoria circumdata*. The presence of *circumdata* characters (i.e. the pink pleuro-marginal ring and pink head markings) on some but not others of this group is typical of an intergrading population. The subject requires more study but for now I believe a subspecies designation best fits the evidence.

Kachuga tentoria circumdata (Mertens 1969)
Pink-ringed Tent Terrapin — Plate II, E+F

Identification: A moderate-sized tent terrapin (to 27.1 CL) having a single large dark blotch on all plastral scutes, a reddish ring at pleuro-marginal juncture of carapace, and reddish head markings.

Description: Males appear somewhat darker than females otherwise sexes colored similarly (FMNH 224162 M) — carapace olive-green with a geranium pink ring around pleuro-marginal juncture; middorsal stripe comprised of streaks of geranium pink bordered by black; plastron straw yellow with large dark blotch covering over half of each scute; bridge and underside of marginals black bordered in yellow; inguinal with black spot but not axillary; seams of plastral scutes and marginals washed with pink; head olive green with a geranium pink circular spot behind eye and a pair of short, oblique, geranium pink bars at posterior of head; iris smoke gray; mandibles

light straw yellow with orange wash becoming olive near snout; neck olive gray with dull, cream colored stripes on sides and venter; rump and base of tail also striped (stripes more pronounced than in other races).

A female (BNHS 1340) was similar but differed as follows: Carapace antique brown with a cinnamon-rufous rather than pink pleuro-marginal ring; middorsal stripe vague, almost nonexistent; head markings less red and more cinnamon rufous; two irregular spots (instead of bars) present at back of head.

Size and Sexual Dimorphism: Females greatly exceed males in size. A collection of thirteen females from the Chambal River in the Morena District of M.P. ranged from 18.1 to 27.1 (mean 22.1) cm CL. A sample of 11 males from the Yamuna River in the Etawah District of U.P. ranged from 7.7 to 8.8 (mean 8.3) cm CL. Measurements of a typical male and female are:

FMNH 224162 M — 8.4 CL 6.7 CW 7.8 PL 4.6 H and 0.0825 kg.

Live F — 23.3 CL 17.2 CW 22.5 PL 11.2 H and 1.6 kg.

In addition to size males differ from females by having a longer tail with a proportionately thicker base.

Hatchlings: A single hatchling from an egg obtained at Deogarth Ghat, on the Chambal River measured 3.7 CL 3.5 CW 3.4 PL 2.1 H and weighed 11.5 g. Coloration — carapace smoke gray with vague dark mottling on most scutes with a cinnamon-rufous pleuro-marginal ring; anterior portion of middorsal stripe also cinnamon-rufous bordered with black; plastron straw yellow with large, black blotches covering most of the scutes and light cinnamon-rufous along scute seams; head olive with bright geranium pink markings including a spot at posterior edge of upper eyelid and adjacent skin, a larger postocular spot and a transverse bar across back of head; chin with three additional pink spots along lateral edge of mandible; iris light gray; neck with cream stripes on an olive gray background; limbs gray with cream-colored scutes, webbing and lateral skin flaps; rump with dark and cream stripes. See Moll (1985) for a colored photograph.

Natural History: The pink-ringed tent terrapin is a riverine form which readily basks at any opportunity. We observed hundreds of these turtles basking on logs, islands and along the banks of the Yamuna and Chambal Rivers. In January when the larger *Kachuga* were scarce and presumably dormant, this species was still basking in some number along the Chambal. There is some indication of habitat separation between the sexes and age groups — small males and juveniles were rarely seen in the river proper where females were common. However, in a backwater behind a sandbar projecting out from the shore of the Yamuna River, we once collected 11 males, 6 juveniles and 3 females. Three yearlings were also captured in a small (10′ wide) weedy tributary of the Chambal hiding in and around vegetation masses.

Digestive tracts of one male, one female and two immature females were examined. The male contained a beetle and an equivalent amount of aquatic vegetation whereas the female guts were packed with vegetation alone. This supports findings from the other races indicating that females tend to be chiefly herbivorous while males are more omnivorous.

Nesting was occurring along the sandbanks of the Chambal River when we arrived there on 19 January but all nests found had been destroyed by predators. Jackal tracks and occasionally hyena tracks were associated with these nests. Two eggs, one cracked and one entire remained in one of the open nests. The cracked egg measured 47 × 28 mm while the

entire egg was 47 × 27 mm and weighed 19.5 g.

Rao and Singh (1985) reported that nesting occurs from October through January in the National Chambal River Gharial Sanctuary. They calculated the turtles' average clutch size as 6 (3-12) eggs and thought two clutches to be typical. Mean egg size was 48.6 × 27.6 mm and 21 g. Using data from eight of their females, I caculated the mean female reproductive effort as: RCM — 0.08, ELI — 22, EWI — 12, and EMI — 1.4.

Distribution: The pink-ringed tent terrapin occurs in the upper and central Ganges and such tributaries as the Hindon, Yamuna, Chambal and Gomati. Mertens (1969) named the type locality for this race as Meerut, Meerut District, U.P. He was not confident about the localities of his paratypes which were listed as Calcutta or vicinity of Calcutta. Based on our observations from this survey, it seems likely that Merten's paratypes were market specimens shipped in from more western states. Because of the heavy market trade in turtles of West Bengal, distribution records from this state are often unreliable. More likely the race of tent turtles which occurs naturally in West Bengal is *K. t. flaviventer* or some as yet undescribed population. Specimens of this race were collected at the following localities on our survey:

FMNH 224105 & 224109 — Hindon River, nr. Ghaziabad, Meerut Dist., U.P.

BNHS 1335 & FMNH 224162 — Yamuna River, 5 km S Etawah, Etawah Dist., U.P.

BNHS 1340 — Chambal River, Deogarth, 30 km NE Morena, Morena Dist., M.P.

FMNH 224185 — Gomati River, nr. Lucknow, Lucknow Dist., U.P.

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THE BUTTERFLIES OF THE NILGIRI MOUNTAINS OF SOUTHERN INDIA (LEPIDOPTERA: RHOPALOCERA)[1]

Torben B. Larsen[2]

This paper is an account of the three hundred or so butterflies to be found in the Nilgiri Mountains of southern India. Special emphasis is placed on placing the butterflies in perspective in relation to a number of defined ecological zones. Following a description on the climate, topography and vegetation zones in the Nilgiris is a section on the history of entomological exploration. The major part of the paper is devoted to a summary account of each species known to occur in the Nilgiris. Every attempt has been made to update the nomenclature which is cross-referenced to that of Wynter-Blyth (1957) whose nomenclature actually dates back to the 1930ies. Since this nomenclature is the same for most of peninsular India and since the Nilgiris contain populations of virtually all species known to occur in southern India, the paper should also be useful out of the specific Nilgiri context. The data included will be the basis for a later analysis of the ecological and zoogeographical nature of the Nilgiri butterflies, but some initial non-quantitative conclusions are discussed.

Introduction

The Nilgiri Mountains

The Nilgiri Mountains are situated in South India with their centre at 11°25′N and 76°45′ E. The name means Blue Mountains and was bestowed upon them by the plains people at least 700 years ago when the Nilgiris were only seen rising in the distance from the steaming and insalubrious jungles that surrounded them.

The Nilgiris are a well-defined massif that forms the southern limit of the main Western Ghats system that stretches unbroken from Bombay in the north. To the immediate south of the Nilgiris is the Palghat Gap, a stretch of dry lowlands separating the South Sahyadri from the main Ghats system. The distance is not great and on a good day the nearest of the South Sahyadri ranges, the Annamalais, is clearly visible from the Nilgiri plateau.

To the northeast the precipitous Moyar Gorge creates a narrow boundary between the Nilgiris and the Biligiriranga Mountains. The latter can be looked at as the southwestern link, though at best a tenuous one, with the Eastern Ghats system.

The Nilgiris may be described as a right-angled triangle with the right angle placed in the northwestern extremity. The western slopes of the main plateau rise abruptly from levels of 100 to 300 m through a steep escarpment to 1800 m or so. At this level the Nilgiri Plateau commences. Though less precipitous the same situation pertains to the southern slopes. The northern slopes rise from the Mysore Plateau from levels of 700-900 m in a less precipitous manner still, and they are hence rather less imposing. However, the Nilgiris most certainly are a sharply defined geographical feature.

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The plateau of the Nilgiris is hardly a plateau in the strict sense of the word. Valleys drop to 1600 m and peaks rise to more than 2500 m, but most of the area is an undulating landscape confined within the 1800 m contour of the scarp and technically the expression plateau is correct (though slightly disconcerting to an author from a country in which the highest point is some 180 m and lovingly known as the Mountain of Heaven).

Just to the north of the Nilgiris proper lie the Ouchterlony Valley and the Wynaad with an average elevation of 1200-1300 m, providing level country at an altitude not found elsewhere in the range. They form an integral part of the Nilgiris as well as the link with the Western Ghats proper and will be included in the systematic part of the paper.

When making ones way through the Nilgiris, whether by car or by foot, it is easy to forget how small a geographical feature they actually are. The western slopes extend some 40 km due south, the southern and the northern slopes are both some 60 km. As will be seen there can be few areas of similar size with as much ecological variation within its boundaries.

The area covered by this paper is the Nilgiris as a geographical feature, from the surrounding lowlands to the highest peaks. Most of this falls into the administrative Nilgiri District (PIN 643 000) of Tamil Nadu State, but much of the lower parts of the western slopes fall into the Mallapuram and Palghat districts of Kerala State, while portions of the southern slopes fall into Coimbatore District of Tamil Nadu.

The northern borders of the area covered are clearly defined by the Moyar river, and most of the southern border is defined by the Bhavani river. Elsewhere the limit is simply taken as the foot of the mountains and the immediate surrounding plains.

Climate

Situated at 11° north the Nilgiris are well into the tropical zone with the result that temperature variations during the year are relatively modest. Mean monthly averages between the coldest month (December or January) are normally no more than 5°C below that of the warmest summer month (usually May). However, the altitudinal temperature differences are highly significant. The annual mean temperature is 28° at the foot of the southern slopes and only about 15° in Ooty at 2200 m. These altitudinal temperature differences have profound ecological effects. Average monthly temperatures for selected localities are given in table 1 below.

Rainfall patterns are dominated by the monsoon regime that affects all of India, but different parts of the Nilgiris are affected in different ways. The SW monsoon normally commences in the latter part of May or in early June, continuing till some time in September with the occasional pauses. This is India's life sustaining main monsoon, but the positioning and topography of the Nilgiris are such that the main effects of the SW monsoon are felt on the western and northwestern slopes. The southern and northeastern slopes are partly in a rain-shadow and receive as much of their total rainfall from the retreating NE monsoon as they do from the main monsoon. The plateau receives rain in an intermittent fashion from both the monsoons and from more localised thunder showers at other times of the year.

The first four months of the year (January to April, and much of May) are everywhere rather dry, though the southern slopes get some rain even then. Interestingly this dry season is most marked on those parts of the western slopes that otherwise receive more precipitation than any other areas of the Nilgiris. But for the very pronounced drought

TABLE 1

AVERAGE MONTHLY TEMPERATURE IN CENTIGRADE FOR SELECTED NILGIRI LOCALITIES

Month	Bhavani S. 290 m	Kallar 457 m	Silent Valley 914 m	Coonoor 1747 m	Ooty Bot. 2225 m
JAN.	25.3	23.9	17.8	13.7	13.1
FEB.	29.9	25.8	19.5	15.2	13.8
MAR.	29.4	28.3	22.3	17.0	15.2
APR.	31.6	28.9	23.6	18.7	16.4
MAY	31.5	29.0	23.5	19.6	16.8
JUN.	31.0	27.7	20.7	18.8	15.4
JUL.	29.9	26.8	18.8	18.2	14.4
AUG.	30.0	27.0	19.2	18.1	15.2
SEP.	29.9	26.9	19.8	17.6	15.4
OCT.	28.1	26.4	20.1	17.1	15.1
NOV.	26.5	25.0	19.3	15.5	14.1
DEC.	25.0	23.5	18.3	14.1	13.3
ALL YEAR	28.8	26.6	20.2	16.9	14.9

Source: von Lengerke (1977)

the wetter parts of the Nilgiris would doubtless be even more rich in flora and fauna than they already are. I suspect that the exceptional richness of the flora and fauna at Kallar, a locality with a relatively modest 1500 mm of rain a year, is due to the fact that it is exceptionally well distributed in time, avoiding periods of pronounced drought. Some illustrative examples of rainfall patterns are given in table 2 below.

The volume of rainfall varies by a factor of more than twelve in the Nilgiris. Both lowland and highland areas of the western slopes that are fully exposed to the SW monsoon receive more than 6000 mm a year, and more than 3500 mm is normal in this area. The driest parts of the Moyar Gorge, an area in permanent rain shadow, receive less than 500 mm. Some examples are given in table 3 below, compressing data from table 2 above.

Ecology

Rainfall patterns, temperatures and to a lesser extent topography combine to produce in the small area covered by the Nilgiris a network of very complex ecological conditions with a degree of variation that is not usually found in so small an area. Given the statistics this is not surprising: Elevation ranges from 100 m to well over 2500 m; rainfall from less than 500 mm a year to more than 6000 mm, perhaps in some cases much more; the lowest temperature ever recorded at the foot of Nadgani Ghat is about 18°, while frost is a regular feature at Ooty and elsewhere on the plateau.

While broad ecological zones of considerable diversity can be identified the net result is not always a very tidy pattern because of topographical quirks, rain-shadows and local peculiarities. To give one example. The

TABLE 2

ANNUAL RAINFALL IN SELECTED NILGIRI LOCALITIES (BY MONTH AND YEAR TOTAL IN MM)

Locality	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL TOTAL
Mukurti Ridge 2545 m	11	7	17	76	311	1358	2279	1259	583	309	83	37	6330 mm
Woodbriar 1143 m	12	10	21	122	163	415	580	346	196	195	90	29	2179 mm
Kargudi 1173 m	8	1	5	58	120	295	251	208	95	102	37	19	1199 mm
Ooty Obs. 2249 m	21	9	22	76	172	113	177	135	108	195	111	60	1200 mm
Kotagiri 1982 m	16	3	9	77	159	123	191	134	103	241	156	52	1264 mm
Kodanad 1951 m	48	17	33	106	175	78	104	99	129	317	245	106	1457 mm
Kinakorai 1737 m	66	55	57	109	94	38	73	56	66	270	288	147	1319 mm
Kallar Gdns 457 m	74	100	73	136	103	35	64	86	98	288	315	106	1478 mm
Mettupalayam 329 m	26	32	33	73	89	20	35	40	54	188	172	61	823 mm
Bhavanisagar 290 m	7	35	53	48	89	30	30	42	70	183	131	37	775 mm
Nadgani 747 m	7	15	12	64	172	545	898	690	333	246	100	25	3107 mm
Silent Valley 914 m	13	7	47	70	289	786	1106	788	348	338	142	34	3968 mm
Moyar Gorge 880 m	12	2	8	41	102	17	50	32	49	128	65	32	538 mm
Glenburn 1067 m	93	96	78	116	107	54	82	94	105	306	335	141	1607 mm

Source: von Lengerke (1977).

Nadgani site where many of the species recorded in the systematic part were observed probably had a rainfall of about 6000 mm a year, but just two kilometres further west, where I usually camped, rainfall was down to 3000 mm. On many occasions I was repeatedly drenched during a day's collecting only to come back and find that there had been no rain at the camp site.

TABLE 3

TOTAL RAINFALL IN FOUR SELECTED NILGIRI LOCALITIES AND ITS DISTRIBUTION BETWEEN SW MONSOON MONTHS, NE MONSOON MONTHS AND THE DRY SEASON IN PERCENT

Season	Western Silent Valley 914 m	Southern Kallar 457 m	Northern Moyar 880 m	Plateau Kotagiri 1982 m
SW Monsoon (May-Sep.)	83.5	26.1	46.5	56.2
NE Monsoon (Oct.-Dec.)	13.0	47.9	41.8	35.5
Dry Season (Jan.-Apr.)	3.5	26.0	11.7	8.3
TOTAL	100	100	100	100
Rainfall mm	3968	1478	538	1264

Source: Calculated from table 2.

Such differences make the development of a broad ecological framework difficult, though such a framework will be essential for a subsequent interpretation of the total Nilgiri butterfly fauna in ecological biogeographical terms. I have however, attempted to make such a framework based on the work of previous authors, leaning heavily on a simplified version of the forest classification by Champion & Seth (1968), as well as on my own observations and conclusions.

Ecological framework for the Nilgiris

For the purposes of analysing the butterfly fauna I have arrived at a classification framework covering twelve main ecological zones. The first, and rather crucial division is one based on altitude, the attendant climatic differences, and their joint effect on the floristic and faunistic composition. On this basis the Nilgiris may be divided into three major divisions as follows:

TROPICAL/LOWLANDS	100-1500 m
SUBTROPICAL/MIDDLE LEVELS	1500-1900 m
MONTANE/PLATEAU	1900 m+

The exact altitudes of change from one division to the next is subject to local variation and there is often a transition zone. Where the subtropical division merges directly with evergreen tropical forest it may be difficult to define when the transition between the two has actually been effected.

The following paragraphs briefly characterise the salient features of each of the eleven zones, which are then again summarised in table 4.

TROPICAL DIVISION

1. *Rainforest zone.* Where rainfall exceeds 3500 mm a year in the lower part of the tropical division, and if topography does not militate against it, the climax vegetation becomes a fully developed rainforest system approaching that called giant evergreen by Champion & Seth (1968). There is a closed canopy and several storeys with an amazing faunal and floral diversity. Most of the Nadgani Ghat and some areas near Mukkali at the base of the Silent Valley access road belong to this zone. Were it not for the fact that the dry period from January to April was very severe the number of species would be even greater, but some species without diapause mechanisms cannot survive. A significant number of the most interesting South Indian butterflies are effectively limited to this zone.

2. *Wet Evergreen zone.* This zone is characterised by a lower rainfall than the previous

one, ranging from 1800 mm a year to 4000 mm at the higher levels of the tropical division. Visually it is less grandiose, the trees lower, and the typical storied structure of true rainforest has become a confused tangle. It covers the West Coast Tropical Evergreen of Champion & Seth (1968), and in the zone I also include the patches of evergreen found on the southern slopes which they would classify as Semi-Evergreen. From a butterfly point of view it is characterised by a great degree of species diversity, the absence, or near absence, of the true rainforest elements, and the fact that species from the more open formations still do not penetrate. Much of the forests of the western slopes fall into this category. I have not worked any spot in this zone consistently, but Kallar forms a transition between it and the mixed deciduous forest (see 4 below).

3. *Wet Agricultural zone.* Till a few centuries ago the entire western slopes and good parts of the southern slopes were covered with evergreen forests of the two types discussed above. Both are very fragile eco-systems that do not take kindly to human interference and where wood has been exploited virtual ecological deserts result, clad only in grasses and one or two dominant dicotyledons. Such areas are entomologically useless, but unfortunately they prevail over long stretches. Much of the area has been under agriculture for the past few centuries, with rice, bananas, turmeric, rubber, palm crops, pistachio and various fruits as the main crops. Plantation teak is the worst of all. Any butterflies that remain are found in fringing riverine forest and untidy gardens, but they are not many. A very few skippers thrive on the rice and some common butterflies of the more open formations manage to establish populations, but on the whole wet agricultural lands are disappointing for butterflies, except that the occasional forest species maintains a surprising foot-hold here and there.

4. *Mixed Deciduous Forest zone.* Much of the lowland southern slopes and the central parts of the northern slopes consist of dense mixed deciduous forest with considerable floral and faunal diversity and a wide range of micro-habitats in response to climatic and topographical variation. Wherever permanent moisture is available there is an admixture of evergreen plants, occasionally leading to local almost evergreen patches. The rainfall regime is usually in the range of 1000 to 1800 mm. The physical aspect is a low, but very dense forest, at times almost impenetrable. At the upper levels it merges gradually with the subtropical evergreen forest on the southern slopes. The mixed deciduous forest is very different from the moist-deciduous forests of the Wynaad and the Mudumalai Wildlife Sanctuary, which are very open with tall teak as the dominant tree. Moist-deciduous forest is a relatively poor butterfly habitat which is weakly represented in the Nilgiris proper and not dealt with separately in this paper, though notes are given at relevant points in the systematic part. The whole of the Kotagiri Ghat below Kunjapannai is typical of the mixed deciduous forest zone.

5. *Thorn Forest zone.* Once rainfall drops to between 500 and 1000 mm the natural climax vegetation becomes some form of savanna-like forest which visually is not dissimilar to parts of East Africa and where, in fact, much of the dominant vegetation has African affinities, not least species of *Acacia.* This is also the home of one of the Indian antelopes, the Blackbuck. The floral and faunal composition is much less diverse and varied than the mixed deciduous forest. Most of the area between Masinagudi and Bhavanisagar via the Moyar Gorge forms part of this zone, but it is also represented at many places in

the foothills of the southern slopes, when rainfall is not high enough to support mixed deciduous forest. It is also the home of the most typically African of the South Indian butterflies.

6. *Dry Agricultural zone.* Most of the land at the foot of the forested slopes now consists of non-irrigated farmlands, much of which would have been thorn forest, and in favoured localities mixed deciduous forest. Often rocky outcrops and natural fences are left untended. Such areas contain many of the species characteristic of thorn forest, but by and large it is a very poor butterfly habitat. Here and there irrigated agriculture prevails. Except where trees and palms are grown, such areas mainly contain the most common plains species and those that have adapted to man-made environments. At Kallar, with its extensive plantations, some forest species, even those of the evergreen forests, survive. Most of these would probably be absent if Kallar were not immediately adjacent to undisturbed forest.

SUBTROPICAL DIVISION

7. *Subtropical Evergreen Forest zone.* The exact altitudinal boundaries of the subtropical zone vary from 1200/1500 m to 1800/1900 m depending on local circumstances, and once these elevations are reached the extreme differences in annual precipitation that create such diversity in the tropical zone have largely disappeared. Consequently the range of vegetation zones has also narrowed, and the predominant climax vegetation of the western and the southern slopes is subtropical evergreen forest, except where the scarps are so steep that forest cannot cling to them. Where the subtropical forests abut tropical evergreen forests (e.g. at Silent Valley) the transition between the two is both visually and floristically very gradual. Elsewhere the transition between mixed deciduous and subtropical evergreen is abrupt and very noticeable, such as on the Kotagiri Ghat. Climax subtropical evergreen forest is often almost impenetrable. As far as the butterflies are concerned this zone has a small, but conspicuous, special element. Most of my own experience of this zone is from the forests at Glenburn and Kunjapannai.

8. *Sub-climax Subtropical Forest zone.* In areas of low rainfall on the northern slopes and in disturbed and rocky areas of the southern slopes the subtropical evergreen forest cannot develop fully. The result is some impoverished associations drawing from the evergreen and deciduous zones the most hardy species, interspersed with grasslands. These are very poor habitats with no major influence on the Nilgiri fauna.

9. *Subtropical Agricultural zone.* Most of the subtropical zone has been converted to plantation agriculture, with coffee at the lower reaches and tea at the upper. On the whole these are poor butterfly habitats, not least because weedicides and pesticides are applied liberally, frequently and consistently. Butterflies are only found along streams which, at least in the coffee country, often has a belt of fringing, riverine vegetation. Tea country is a virtual ecological desert, only a handful of butterflies managing to survive. The grassland areas are indicators of recent forest destruction and are not natural habitats for any species.

MONTANE DIVISION

10. *Montane Evergreen Temperate Forest zone.* The plateau of the Nilgiris, mainly above 1900 m, has two characteristic types of natural vegetation. The evergreen forests known as *sholas,* often growing only in sheltered places, and rolling open grasslands with only a few *Rhododendron* trees. The sholas are dark, almost impenetrable forests, their edges often shaped by the prevailing winds. Typical *sholas* develop under rainfall regimes from as

low as 1200 mm to as high as 6000 mm+ without displaying much difference in floral composition or physical aspect. The reason for this is that the *sholas* in the most heavy rainfall area have a rapid run-off of excess water. Patches of *shola* remain over most of the plateau, and extensive forests may still be found in the Kundahs, at Avalanche and in the Mukurti Peak area. One of the prettiest and most accessible is the Longwood Shola near Kotagiri, which has a most attractive bog at its centre. The floral composition is characterised by a large proportion of plants with Palaearctic and Oriental montane affinities.

11. *Montane Grasslands zone.* In between the *sholas* the normal vegetation consists of rolling grasslands, but this is now in evidence only in the remoter parts towards the western escarpment between the Sispara Pass and Mukurti Peak. Elsewhere they have been converted to tea. These grasslands are the home of the famed Nilgiri Tahr. Champion & Seth (1968) are insistent that the grasslands are derived and that the entire plateau was once clad in forest. The presence everywhere of the fire resistant *Rhododendron* is their main evidence. Ranganathan (1938) takes issue with this (referring to the first edition of Champion), pointing out that wind and frost would preclude *shola* vegetation in some parts of the plateau. Blasco (1971) would appear to support the latter viewpoint. I do not have the expertise to settle the matter, but certainly the vegetation of the grasslands is both more complex and more varied than in the recent grasslands of Sumatra and Papua New Guinea which are definitely the result of human intervention. Grasslands were extensively present when the first explorers visited the Nilgiris just 150 years ago. It is difficult to see how a tiny handful of Toda pastoralists could, or for that matter should, have indulged in massive deforestation.

12. *Montane Agricultural zone.* Whether or not the montane grasslands are derived, it is a fact that more than three quarters of the plateau has been heavily modified by human intervention. Beginning in 1832 large areas have been forested with exotic trees, especially of Australian origin (*Acacia dealbata, A. decurrens, A. melanoxylon* and *E. globulus*). One of the latter is now at 78 m one of the tallest trees in all of India. Somewhat later a number of temperate conifers were also planted. Virtually any tree from anywhere that was of potential promise has been tried out in the Nilgiris and remnants are sometimes found in surprising places. The amount of tree planting may well have exceeded the deforestation in some areas, but diversity was sacrificed for monoculture. In the Ooty area some homesick English gentlemen spent their summers strewing about the seeds of broom and gorse on the downs, with the result that these plants are locally dominant. Since their arrival some 400 years ago the local Badaga have concentrated on the cultivation of vegetables with potatoes, carrots and cabbages as the main crops, though wild boar is a perennial problem. However, in terms of both area and visual impression it is tea, tea and yet more tea that predominates as a never-ending ecological desert.

Summary

This concludes the brief overview of the Nilgiri ecology and outlines the twelve ecological zone which will later be used for an analysis of the ecology and zoogeography of the butterfly fauna. Table 4 below gives a brief summary of the information. As already mentioned a somewhat robust approach is called for when dealing with major ecological zones in a area where so much variation can be found within a few kilometres.

Only a robust approach can impose some element of order into what sometimes appears to be anarchy; it should not be used to obscure the fact that genuine anomalies exist and that surprises do occur. It is also necessary to highlight once again the fact that much of the area, especially that above 1200 m, has been the subject of very intensive human intervention for the past 150 years. It its good to know, though, that representative portions have been maintained for posterity. The proposed inclusion of the Nilgiris in the World Biosphere Reserves scheme will hopefully ensure that the environment is gradually improved. Few places contain as much diversity within so little space as the Nilgiris. As an ecosystem it demands our respect.

Table 4

SUMMARY OF THE TWELVE MAJOR ECOLOGICAL ZONES OF THE NILGIRIS

TROPICAL DIVISION (100-1500 m)

1. RAINFOREST ZONE

Rainfall 3500 mm+; temperature range 22-30°. Tall closed canopy forest with little undergrowth except where bamboo prevails. *Hopea, Dipterocarpus,* many Guttiferae, many Anacardiaceae, Sapotaceae, Meliaceae, etc. Great floral and faunal diversity. Strong affinities to Sundaland. Only western slopes and not usually above 1000 m.

2. WET EVERGREEN ZONE

Rainfall 1800-3500 m; temperature range 18-28°. Dense closed forest, lower than previous zone, and often with well-developed undergrowth. Much local variation and transition to moist-deciduous or to semi-evergreen depending on specific circumstances. Most of western slopes and part of southern slopes.

3. WET AGRICULTURAL ZONE

Rainfall 2000-5000 mm; temperature range 18-30°. Main crops rice, coconut, coffee, cardamom, fruits and plantation trees. Mainly at the foot of the western slopes. Some of the slopes are grasslands of little diversity slowly regenerating to forest.

4. MIXED DECIDUOUS FOREST ZONE

Rainfall 1000-1800 mm; temperature range 20-30°. Low dense forest with thick undergrowth though patches of teak and figs may be taller. Typical trees *Anogeissus, Boswellia, Tamarindus, Santalum, Moringa.* Some penetration of African derived flora. Mainly southern slopes and parts of Mudumalai, but also in western slopes rain-shadows.

5. THORN FOREST ZONE

Rainfall 500-1000 mm; temperature range 22-33°. Open savanna forest with *Acacia, Zizyphus, Euphorbia* and other African elements as dominants and much admixture of Afrotropical flora. The eastern half of the northern slopes, the eastern third of the southern slopes, and locally on the southern foothills where not disturbed by agriculture.

6. DRY AGRICULTURAL ZONE

Rainfall 500-2000 mm; temperature 20-35°. Crops are mainly rain-fed millets and certain pulses. Many tropical weeds and some remnants of thorn forest vegetation. Very dry during dry season, prone to drought. Much of the plains adjacent to the southern and northern Nilgiris where forest has been lost.

SUBTROPICAL DIVISION (1300-1900 m)

7. SUBTROPICAL EVERGREEN FOREST ZONE

Rainfall 1300-4000 mm; temperature range 15-25°. In some respects transitional between tropical and montane evergreen but with some special elements. *Olea dioica* is typical. Dense dark forests, now much reduced in extent. Most of western and southern slopes where not cut down, and parts of the NW slopes above the Wynaad and Ouchterlony.

8. SUBCLIMAX FOREST FORMATIONS ZONE

Rainfall 1000-1600 mm; temperature range 18-30°. Impoverished version of (7) above where rainfall and soil is deficient. Often clumps of isolated trees in grasslands. Here and there on northern and southern slopes but of marginal importance.

9. SUBTROPICAL AGRICULTURAL ZONE

Rainfall 1100-4000 mm; temperatures 15-30°. Coffee at lower levels, tea at upper reaches, with vestiges of forest along rivers and where too steep for plantation crops.

MONTANE DIVISION (1800 m++)

10. MONTANE EVERGREEN FOREST ZONE

Rainfall 1400-6000 mm; temperature range 10-20°. Dense evergreen forest with Oriental montane and many Palaearctic plants. Among trees members of genera such as *Ternstroemia, Eugenia, Michelia,*

Gordonia, Rhododendron, etc. Many low montane plants (*Begonia, Lobelia, Impatiens*) and Palaearctic plants (*Fragaria, Viola, Rubus*). Dotted throughout the plateau, but much reduced in extent.

11. MONTANE GRASSLANDS ZONE

Rainfall 1300-3500 mm; temperature range 10-20°. Open rolling grasslands with a somewhat complex structure, much variation in structure according to soil, exposure, drainage and rainfall. Only fire resistant tree is *Rhododendron* but exotic gorse and broom prevalent in many areas. Now mainly from western escarpment system to Mukurti.

12. MONTANE AGRICULTURAL ZONE

Rainfall 1300-3500 mm; temperature range 10-20°. Three types: monoculture of exotic *Acacia, Eucalyptus* etc; monoculture of tea; and vegetable gardening (carrot, potato, cabbage and others) with some fallow land. Presently covers most of the plateau.

HISTORY OF EXPLORATION

General

The Nilgiri Mountains long lay as an isolated and unknown 'jewel of nature' protected by a wide band of malarious jungles, guarded by tigers and fierce elephants, largely unknown to the outside world. On the plateau lived the pastoral Todas exploiting the extensive grasslands, with primitive hunters and gatherers in the surrounding forests, but never exceeding the 10.000 mark as far as population was concerned. Their impact on the environment must have been marginal, but they developed a culture and a matrilineal kinship system that has been the delight of anthropologists. More must have been written per capita of the Todas than of any other people. The Kotas provided supplementary skills in the type of symbiotic relationship that pastoralists often develop with other groups. Lower down the mountain lived primitive hunter-gatherer societies, Irula, Kurumba, Panniya and related tribes. Their numbers were, in total, somewhat larger than that of the Todas, but they lived in harmony with nature and had neither the skill nor the inclination to encroach in any major way on the natural conditions.

Some four hundred years ago the Badaga appeared on the scene. They were Kannada speaking people fleeing some political upheaval in what is now Karnataka, possibly the repercussions of the Bijapur Muslim conquest of the Vijayanagar empire. They were the first agriculturalists on the plateau and settled in the villages that still carry their original names, digging their fields, but not maintaining much contact with their area of origin. Though probably more in number than the resident Todas, it seems that a *modus vivendi* was arrived at so that frictions between the radically different life styles of the two groups were minimised. Life probably went on much as it had always done, except for the compact Badaga villages and their agriculture. We do not know, it has to be said, because information on the Nilgiris was almost nil and no written tradition exists.

Just around 1600 the modern world made its way to the Nilgiris. Rumours of Christian communities in the distant mountains, derived from the visit of the Apostle Thomas in the early days of Christianity, reached the court of the Bishop of Calicut. He sent off a group of Portuguese priests to investigate matters, but his judgment in choice of emissaries was not too sound. They came back with a report that was not 'so sure and complete as was desirable', a rather nice turn of phrase. So a few years later, in 1603, heavier guns were brought to bear. The Jesuit Father, Jacomo Ferreira, led an expedition on behalf of the Bishop of Malabar in Calicut. He brought back a fair amount of circumstantial and anecdotal information, but of one thing he was certain .... there were no Christians in the Blue Mountains, and so the Portuguese lost interest.

In 1799, after the defeat of Tipu Sultan at the hands of the East India Company, the Nilgiris were part of the territory ceded to the Company through the treaty of Sriranga-patna, though probably Tipu never held much actual sway north of the Wynaad. The mountain was visible to the large British garrison and civil establishment at Coimbatore, but it was only in 1812 that the first representative of the colonial power visited the mountain itself. This was in the form of a somewhat unimaginative tax collector whose only comment was that the Nilgiris were not worth any particular efforts on his behalf A more official and less single-minded party set off during the winter of 1818-1819. They reported back with enthusiasm on the climate, vegetation and wildlife of the plateau, in fact describing a paradise on earth. They were perhaps over-enthusiastic, because their reports were flatly disbelieved at Fort St. George in Madras .... or at least as flatly as bureaucratic niceties would allow: It is somewhat difficult to accept ..... the understandable enthusiasm of a group of men ..... notwithstanding .... etc.

But truth will not be concealed, and soon the Collector of Coimbatore became the driving force in the establishment of the Nilgiris as a major hill resort. By 1827 there were seventeen European houses in Ooty and five in Kotagiri. Ten years later large scale establishment of plantations was in full swing and the destiny of the Nilgiris was changed forever. The population swelled with an influx of Tamil speaking plains people, needed for the tea and coffee plantations. The main towns of Ooty, Coonoor and Kotagiri became trading centres over and above their recreational function. By 1860 the foundations of what the Nilgiris still are to-day were laid.

Entomological exploration

Butterflies from India reached the scientific community already at the time when Carl von Linné published his tenth edition of SYSTEMA NATURAE (1758), the starting point of zoological nomenclature. This book contains many Indian species, and many more were described by Fabricius and Cramer in 1775. Soon after the Nilgiris were opened up they were visited by explorers and naturalists, both professional and amateur. The first of these was the Austrian nobleman and naturalist. Baron von Hügel in the late 1830ies. His material was described by Kollar and the Felders. It is, however, striking how relatively late some of the more prominent South Indian endemic butterflies were actually described as evidenced by the list below :

Pachliopta pandiyana Moore 1881
Papilio liomedon Moore 1874
Papilio dravidarum Wood-Mason 1880
Papilio buddha Westwood 1872
Prioneris sita Felder & Felder 1865
Colias nilagiriensis Felder & Felder 1859
Celatoxia albidisca Moore 1884
Parantica nilagiriensis Moore 1877
Idea malabarica Moore 1843
Mycalesis adolphei Guérin-Méneville 1843
Ypthima chenui Guérin-Méneville 1843
Calaenorrhinus ambareesa Moore 1867
Thoressa honorei de Nicéville 1887
Oriens concinna Elwes & Edwards 1897

The first systematic account of the Nilgiri butterflies dates back almost exactly a century when Sir George Hampson [1888 (1889)] made a comprehensive list based on his five years of residence in the Nilgiri Wynaad as a coffee planter. He collected mainly in the northwestern corner, including the Nadgani Ghat, but only in that part which lay in the Madras Presidency, and not the Malabar side, now in Kerala State. His energies were subsequently transferred to moths. On his return to the United Kingdom he joined the British

Museum (Natural History) and produced the magnificent series on moths published as part of FAUNA OF BRITISH INDIA. His total output outstrips most other entomologists that have ever lived, yet despite this, the quality and accuracy of his work is legendary.

Hampson's list contained 275 entries and he expected that 'no more than about twenty species would be added to it'. On current taxonomical view the list actually contains somewhat less than 260 species. In all just about forty species have in fact been added since, but as a first effort it certainly is no mean achievement. It is a great shame that none of his copious field notes were included. They are available in the British Museum (Natural History) but I have not been in a position to avail myself of them.

It is hardly surprising that the nomenclature adopted by Hampson is often difficult to decipher for a contemporary reader. We are therefore indebted to Yates (1935) for 'translating' Hampson's list to the language used by Evans (1932) which is largely intelligiblle to-day, and for adding quite a few species from smaller contemporary collections. Many of Yates's additions were species from the lower parts of the Nadgani Ghat. Yates's list comes to 282 entries, some of which are now considered forms or synonyms.

The next list of Nilgiri butterflies is that of Wynter-Blyth (1944, 1946). At the time he was headmaster at the school at Ketti below Coonoor. Most of his collecting was done at Ketti, and on the Ghat between Coonoor and the plains, and not least at Kallar, a magnificent place for collecting butterflies to this very day. He did make a number of visits to the Nadgani Ghat, but because of wartime petrol rationing he did not visit the lower parts on the Kerala side. In his day, of course, the forests stretched much more east, almost to Gudalur.

His list came to 290 entries, later supplemented with a further twenty or so. Some of these were again synonyms or forms, and one or two were erroneous. His paper is a very solid one with which I have few quarrels. Wynter-Blyth was later to publish the most recent guide to Indian Butterflies (1957) and the influence of his work in the Nilgiris is clearly visible in his book.

Various taxonomic works have since scooped up old unpublished material, and I have collected six or seven species never before recorded from the Nilgiris, so that the present list contains 299 valid species. As shown at the end of the list of Nilgiri butterflies there are about a score of South Indian butterflies that have not yet been recorded from the Nilgiris. Some of these, probably about a dozen, will one day be found also there. They will be an incentive to future collectors, but more precise ecological data and better ethological observations than my own should be the priority, and a much more satisfying prospect that the record of a few additional species.

Current study

I deliberately chose to study the Nilgiri fauna because it was already relatively well known, and because I had some opportunities for comparison stretching back a hundred years. It was clear from the outset that the number of new records would be relatively small, but I was more interested in the general ecology of the area. After publishing this systematic account of the Nilgiri butterflies it is my plan to convert the data into a more formal ecological-cum-biogeographical analysis over the next few years. Also of interest was an assessment of the extent to which the ecological degradation that has taken place in the Nilgiris over the past 100 years had influenced the butterfly fauna. When choosing

the Nilgiris I was not unmindful of the fact that most of the southern mountains in India are basically very similar as far as the butterfly fauna is concerned, except that if tropical rainforest is absent, then so are several of the more interesting butterflies. Had I chosen the Ghats below Sultan's Battery to somewhere in the South Sahyadri I would have had the pleasure of filling out some — largely predictable — distributional blanks, but it would have been at the cost of data on the ecology of the butterflies concerned.

I was in the Nilgiris, with occasional visits to the Annamalais, the Biligiriranga Mountains, and Kanara, from 11.iv to 18.x.1986. During this time I spent roughly half my days in the field visiting all the ecological zones as often as possible. My main areas of work were the Longwood Shola at Kotagiri, the forests around Glenburn, Kotagiri Ghat, Kallar, Nadgani Ghat and especially the little river at its foot, the area around Masinagudi and the Coonoor Ghat. Many other localities were visited once or twice.

It is a pity that I was not able to spend a whole year in the area. The profound dry season from January till April has a very definite effect on the butterflies and it would have been interesting to study this not least in the Nadgani Ghat area. Some species are mainly on the wing during dry season in the rainforest zone. However, I do not think this loss of information has introduced serious bias into the systematic part that follows.

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I am indebted, as often before, to the Danish Carlsberg Foundation whose grants have assisted in making this and other projects economically feasible.

I have not bracketed the names of authors where the genus has been reassigned since the original description since virtually all Indian butterflies are no longer in their original genus.

Systematic part

The systematic part that follows gives the basic data on each of the species that I accept

as having been genuinely reported from the Nilgiris. The basic sequence is that of Eliot (1978) except that the Lycaenidae have been placed before the Nymphalidae in accordance with modern usage. The subfamilies of the Nymphalidae were in older literature usually accorded family rank, but there is increasing agreement that they should not be.

Every effort has been made to refer to the butterflies according to the most modern nomenclature, much of it adopted from Eliot (1978) and a number of recent revisions. It has not been thought the place to discuss nomenclature in any detail, except where excessive confusion might be engendered, or where I have deviated from current practice. Where a name in Wynter-Blyth (1957) differs in genus or species, the name used by him is given in brackets below the current one.

Under each species I have endeavoured to give the status and the distribution in the Nilgiris, with whatever other information that might be of special interest. I have also summarised in brief terms the global distribution of the Nilgiri species. These are not meant to be definitive, but simply to give an impression of how the South Indian fauna is related to its neighbouring regions.

Systematic list of the Nilgiri butterflies

Papilionidae

Papilioninae

TROIDINI

001. **Troides minos** Cramer
(*Troides helena*)

The SOUTHERN BIRDWING is the largest of the Nilgiri butterflies, being endemic to southern India and the Western Ghats. It is replaced by *Troides darsius* Gray in Sri Lanka, while its closest relative in the Himalayas is *Troides aecus* Felder & Felder rather than, as often assumed, *Troides helena* Linné. Haugum & Low (1982-1985) discuss these relationships.

The species is not rare and may even be common on the western slopes during the monsoon and immediate post-monsoon months. The main habitat is lowland evergreen forest, but the species is at home also in mixed deciduous forest and the subtropical evergreen. It is a good coloniser of agricultural lands and is often common in coffee plantations. Wandering specimens are not infrequently met with on the plateau itself though it cannot breed there. The biggest concentration I ever saw was on some land that had been cleared for coffee a few years ago at Kokode Estate near Sholarmuttam. Hundreds were feeding from Lantana growing among the forest trees that had been left as shade trees. The species is active in the early morning, coming down from the tree-tops to feed from *Lantana* and *Mussaenda.* By 10.30 they once again ascend and are then very difficult to catch. Females will often be found sitting with the wings open with up to three males assiduously courting them. The adults do not come to water. In captivity, on cold mornings, the butterflies will increase their body temperature by wing-quivering in the manner of many moths, being able to fly actively under conditions where other lowland species are immobilised. The food plants are *Aristolochia indica* and in the wet zone especially *Thottea wallichi,* a Troides food plant not mentioned by Haugum & Low (1982-85). Much concern has been expressed over the conservation status of Birdwing butterflies worldwide, and the European Economic Community has banned their import and export even for scientific use. The Southern Birdwing is by no means a threatened species, and in some cases its numbers increase through the agricultural activities of man.

002. **Pachliopta pandiyana** Moore
(*Tros pandiyana*)

The MALABAR ROSE is an unusual swallowtail which is endemic to the wetter parts of the Western Ghats system and it is closely related to the Sri Lankan endemic *Pachliopta jophon* Gray. It appears to be strictly limited to the wettest type of rainforest, where it is somewhat local, but sometimes very numerous indeed. I have seen hundreds of fresh specimens of both sexes at *Lantana* on the Nadgani Ghat. Activity began as early as 06.45 when the only other butterflies about were skippers, and it was not unusual to find specimens flying even in heavy rain. It normally flies in dense forest but will visit clearings and roads where flowers grow; at such times the three South Indian *Pachliopta* may be seen side by side though they are normally ecologically segregated. In the forest the flight of the species is very slow at the lower level of the canopy and despite their great difference of pattern the resemblance to *Idea malabarica* is great, though I will not go so far as to postulate a co-mimicry relationship. A specimen escaped from a photo session in Kotagiri and was immediately snapped up by a Red-whiskered Bulbul (*Pycnonotus jocosus*). By the time the bird had moved out of sight the wings of the butterfly had been crumpled up, but the body not yet damaged. I unfortunately did not see whether the butterfly was actually eaten. It is obviously a protected species, but the bulbul would not have known this.

As far as is known the only larval food plants are *Thottea siliquosa*; according to Jason Weintraub this is characteristic for the group to which this species belongs.

003. **Pachliopta aristolochiae aristolochiae** Fabricius
(*Tros aristolochiae*)

The COMMON ROSE is often referred to as being very common, but this is not normally the case in my experience, though it is widespread and obvious. Normally numbers are not all that large, though I did see a huge migration at Kotagiri in autumn of 1957 including millions of this species and of *Pachliopta hector* in roughly equal proportion. It is at home in most types of habitat with the exception of dense, wet forest, but it occurs on the plateau only as a straggler. Contrary to the two other members of the genus the Common Rose will visit water, usually early in the morning well before the Pierids and the *Papilio* begin. Large quantities of water are ingested and immediately excreted through the anus, so obviously salts or nitrogenous substances are extracted metabolically. The flight is slow and deliberate. Flowers are frequently visited and the species often spends the night in communal roosts with *P. hector.* The species is found practically throughout the Oriental region, being replaced by *P. polydorus* Linné in New Guinea. One of the female forms of *Papilio polytes* is an excellent mimic of this butterfly, and in nature it is often necessary to look twice before being certain which of the two species is involved. The female of the Zygaenid moth *Histia nilgira* Moore is a fine example of co-mimcry. I saw it only once, at Glenburn, and it took some considerable time before I realised that it was not a small *P. aristolochiae.* The moth is certainly aposematic and exuded a foul smelling yellow substance from the tegulae when handled. At rest it adopted the normal Zygaenid posture and all resemblance to a swallowtail was lost.

004. **Pachliopta hector** Linné
(*Tros hector*)

The large and beautiful CRIMSON ROSE is endemic to Sri Lanka and South India, being found mainly south of the Godavery river and in West Bengal. There are records also from

eastern Burma and the Andaman Islands. It is sometimes very common indeed, may migrate by the million, and congregates in small forests and fruit tree groves in communal roosts during winter. One such roost at Mahabalipuram in December 1985 must have contained many tens of thousands and possibly more than 100,000. I have never seen as many large butterflies in one place [though of course the wintering sites of the American Monarch *Danaus plexippus* (Linné) would vastly surpass it in numbers]. *P. hector* is very fond of flowers, but never comes to water. The main habitat is open dry deciduous forest and ill-kept agricultural land at low altitudes, though migrants and vagrants will be found to the highest peaks. I once saw the species literally fall out of the sky at Kallar. On closer investigation it turned out that a supernumerary male had attached itself to a copulating couple, clinging so tenaciously to it that the threesome could be lifted off the ground by holding a wing of any of the specimens. The species would repay systematic investigation into diapause and migration.

PAPILIONINI

005. **Chilasa clytia clytia** Linné

The COMMON MIME, in both sexes, occurs in two forms. The typical form, *clytia,* is an excellent mimic of species of *Euploea,* while form *dissimilis* is an equally good mimic of the two *Tirumala* and of *Parantica aglea.* The slow and deliberate flight of the Danaid models is beautifully copied, but try to miss a specimen with the net — off it goes at a speed which would give even a Charaxid a good run for its money. In nature the mimicry, as it often the case, is much more convincing than in cabinet specimens, and I have rarely been quite certain whether I actually had a Mime in front of me before taking it out of the net. Working on Sri Lankan material Clarke & Karunaratne (1967) found that *f. clytia* was the ancestral form, and as in Sri Lanka my own Nilgiri observations indicate that there are two specimens of *dissimilis* to every specimen of the ancestral form. As in *Papilio polytes* the relative proportion of the two forms may vary from place to place. Near Karkala in South Kanara Gordon Thompson and I found *f. clytia* to be more common than *dissimilis.* In the Nilgiris the butterfly is quite rare and at best two or three are seen on any one day. Their main habitat seems to be the mixed dry-deciduous forests at low levels and the lowland evergreen forest. It penetrates the lower level of the subtropical evergreen zone and at Kallar may be found in the Arecanut plantations, probably because the larval food plant *Cinnamonum* is grown there. The adult butterfly will come to both flowers and to water where its habit of hovering above the flower or puddle will tell it apart from the models. The larva is very conspicuous (see frontispiece in Woodhouse) while the twig-like pupa is one of the natural masterpieces of camouflage. The species is found throughout the Oriental region, each subspecies carefully tuned to mimetic resemblance of the local Danaids. It would doubtless be a fascinating laboratory insect for further genetic research.

006. **Papilio demoleus** Linné

The LIME BUTTERFLY is common and may be found anywhere in the Nilgiris, though it does not spontaneously enter the densest and the wettest of the lowland evergreen forests.

However, numbers fluctuate considerably in time and space in a somewhat unpredictable way. It is a pest on cultivated citrus, but it also feeds readily on any type of wild rutaceous plant. I have not found it on cultivated fennel, and it is perhaps surprising that none of the South Indian swallowtails has managed to transfer to this plant. In the immediate pre-monsoon period *P. demoleus* is an avid

participant in mudpuddling assemblies, as many as one hundred being found in tight groups, shoulder to shoulder. The distribution of this Oriental species is somewhat puzzling. The core area includes India to Malaya and southern China, with a secondary area in the Australian region. During the past seven hundred years it has colonised Arabia (Larsen 1983) where it feeds exclusively on cultivated *Citrus* and where it is almost in contact with the African vicariant *P. demodocus* Esper. It invaded southern Iraq from Iran only since 1957 (Larsen 1977a). In recent years it has established populations also in Sumatra and on the Philippines, almost certainly in response to human interference with the natural environment. It is greatly to be hoped that the recent invasions will be well chronicled.

007. **Papilio liomedon** Moore

The MALABAR BANDED SWALLOWTAIL is a close relative of the Oriental *Papilio demolion* Cramer, but is definitely specifically distinct and endemic to the Western Ghats, chiefly in the wettest parts of the lowland evergreen forest zone. It is a rather scarce butterfly which is also somewhat localised. The few Nilgiri records are all from the Nadgani Ghat, and here, too, I saw my own only Nilgiri specimen on flowers (19.0) just on the TN/ Kerala border. In behaviour it is much like the other swallowtails, though according to Gordon Thompson it does not come to water. It is certainly much more common in Kanara than in the Nilgiris, and in late September to early October good series may be collected on the globular red flower heads of *Clerodendron paniculatum* in suitable localities.

008. **Papilio dravidarum** Wood-Mason

The MALABAR RAVEN is another endemic of the Western Ghats system, its closest relative being a species from Assam and Thailand. It is rather more common than *P. liomedon*, but is not frequently met with. The habitat is chiefly the wettest of the lowland evergreen forests and in the Nilgiris the main locality is Nadgani Ghat, though Gordon Thompson has occasionally taken it at Kallar. The colour pattern is reminiscent of the *Euploea* but the flight is very rapid and whether a genuine mimetic relationship is involved is perhaps doubtful. The butterfly has the disconcerting habit of suddenly emerging at furious speed from dense jungle through a road or clearing, only to vanish immediately again. It may be hard to distinguish from *P. polytes* on the wing. Wynter-Blyth (1957) states that it never seems to visit flowers, but that is not the case. I have caught several of my few specimens on Lantana. The species is regularly found at mud patches during the drier months and on hot days.

009. **Papilio helenus daksha** Moore

The RED HELEN is the third largest butterfly of the Nilgiris and is common in the subtropical evergreen forests, relatively common on the plateau, and less common at lower elevations. It is a good coloniser and exists well outside of natural forest, and it is one of the few large butterflies to be found in tea plantations. It is, however, unable to survive in the drier thorn forests. It is very fond of Lantana blossoms and will sometimes assemble on mud patches, usually in the company of other swallowtails, but not usually with the large agglomerations of Pieridae. The weaving, random flight looks most haphazard, but in fact the butterfly makes rapid progress and is very difficult to catch. It seems to feed on virtually all available rutaceous plants and is easily bred. The global distribution covers almost the entire Oriental region as well as the southern fringes of the Palaearctic in China and Japan. Colour pattern apart, the similarity between this species and *P. paris tamilana* is strong, and it is interesting that the

South Indian subspecies of both should be the largest of them all.

010. **Papilio polytes polytes** Linné

The COMMON MORMON is indeed a common butterfly at lower and middle heights, but it does not ordinarily breed on the plateau, though from time to time it is seen even on the highest peaks. Like others of its kind it does not really penetrate virgin evergreen forest, though it colonises whenever it is disturbed by human activity. It comes to flowers readily and sometimes large numbers of males are seen mudpuddling. Such assemblages are usually independent of the Pierid agglomerations, occupying somewhat shady spots, often in the company of *P. crino* and other swallowtails. The largest assembly that I have personally witnessed consisted of 34 *P. polytes,* 5 *P. crino,* 1 *P. demoleus,* and 2 *Graphium doson.* Two of the three female forms are excellent mimics of two of the red-bodied swallowtails, the Common and the Crimson Rose respectively, while the third female form is almost like the male. The flight pattern of the mimetic forms is also a wonderful copy of the slow and deliberate flight of the models. During my frequent visits to Kallar I noted all females seen in nature, though in many cases it was necessary to check the body colour to be quite certain whether model or mimic was involved. At Kallar the two mimetic forms predominated, the male-like form being rare and constituting less than 5 percent of the total female population. The two mimetic forms were equally common. The precise data are as follows: *hector*-minic 50.4%, *aristolochiae* mimic 45.7%, and male-like 3.9%. This is in marked contrast to the Delhi population of the same species, where some 60% were mimics of *aristolochiae* and about 40% male-like. *P. hector* does not occur in Delhi and the mimetic form is very rare, certainly less than one in a thousand (Larsen 1987). Such differences constitute powerful support for the concept of balanced polymorphism as discussed by Ford (1975). Fryer (1913) bred the species extensively in Ceylon to work out the genetics and found that the male-like form constituted nearly 50% of the total. These results were puzzling to me till I realised that he was breeding the species at an altitude where the models are scarce indeed, just as in Delhi. The Common Mormon is, by any standards, among the world's most interesting butterflies and an excellent insect for both field and genetic studies. An indispensable starting point for any research is the paper by Clarke & Sheppard (1972) on the genetics of the species.

011. **Papilio polymnestor** Cramer

The BLUE MORMON is the second largest of the South Indian butterflies, and it is a pleasure that such a large and handsome butterfly should be common practically everywhere. Only in the driest lowland habitats is it generally absent, though stray specimens will turn up even there. I have seen the occasional specimen at Masinagudi. It is endemic to Sri Lanka and peninsular India, but is closely related to the widely distributed Oriental *P. memnon* Linné. The latter species has a host of mimetic female forms, some being quite similar to *Pachliopta pandiyana,* and it is perhaps surprising that the female of the Blue Mormon is similar to the male. Occasional females have bright red spots at the base of the forewing upperside, a feature which enters the mimetic pattern of some *memnon* forms. This red spot is very much more frequent in Sri Lanka than in the Nilgiris. Possibly the very narrow range and habitat choice of *P. pandiyana* makes it an unsuitable model. The Blue Mormon is found in all types of habitat, flying with a rapid weaving flight, covering long distances. It visits flowers avidly and comes freely to water. Unlike many swallow-

tails it comes to foul substances, otter droppings being a great favourite. I once found three males deep inside a cave where a group of otters had been dismembering crabs. The eggs are laid on all the natural rutaceous plants as well as on cultivated citrus.

012. **Papilio paris tamilana** Moore

The large and brightly coloured South Indian subspecies of the PARIS PEACOCK is the largest of all, and it qualifies among the finest butterflies anywhere in the world. It is found in all types of evergreen forest from near sea level till at least 2400 m, but I suspect its main habitat is the subtropical evergreen forest. It is found locally also in the moist-deciduous forests of the Wynaad and Mudumalai. Wandering specimens may be encountered in open country, even in the centre of Ooty, but this really is exceptional. Normally it does not stray from dense forest. The species is not really rare, though never numerous, but it may be very difficult to catch. Early in the morning it may be caught at flowers, and on hot days it visits damp patches, sometimes settling with the wings held flat against the substrate, which is somewhat unusual in the family. Unusual, too, is the fact that females are often found in this way. At Sholayar in the Annamalai Mountains I found the species hilltopping along a ridge in primary forest and saw two copulating pairs. I can subscribe to the view of old observers that *P. paris* has fixed patrol routes in its jungle habitats .... if you miss a specimen it is likely to reappear an hour or so later from the same direction. They are fond of flowers, and when half a dozen or so are feeding on the same Lantana patch, the sight is a highlight of all that is enjoyable in natural history. The species is found in South India (but not Sri Lanka), in Orissa, and then from Kumaon east to most of the Oriental region. It is curiously absent from Malaysia.

013. **Papilio crino** Fabricius

The COMMON BANDED PEACOCK is endemic to peninsular India and Sri Lanka. I have seen no phylogenetic reconstruction of the group, but it would appear that the species is fairly isolated. In South India it is more or less restricted to lowland mixed deciduous forest, with only the slightest of colonising ability. I have, however, in December 1983 seen it in the centre of Mysore, from where it was not recorded in lists from early this century (Watson 1890). The closest South Indian relative of *P. crino* is *P. buddha* which is essentially limited to the wettest parts of the evergreen zone with the result that the two species are hardly ever sympatric. *P. crino* is somewhat migratory so it may on occasion be found far from its natural habitats. The species is not very common in the Nilgiris, except at Kallar, where it may abound about the time of the onset of the monsoon. A few years ago several thousands were caught during one season on behalf of Japanese commercial collectors, but the population does not seem to have suffered. The species is very fond of mudpuddling and I have seen more than a dozen assembled, though none was a female. Both sexes come to Lantana, though visits to flowers are infrequent at the time when mudpuddling is at its maximum. The courtship display, with the male hovering below the female, is very similar to that of *P. polytes.* The larval food plant is known to be *Chloroxylon,* the Satinwood tree, but it seems that no-one has found the larva recently, and I was wholly unsuccessful in this respect.

014. **Papilio buddha** Westwood

The BUDDHA PEACOCK is arguably the finest butterfly in South India. The general pattern is not unlike that of *P. crino* and on photographs they may look alike. In real life the Buddha is so much brighter and more

beautiful than the other gloss swallowtails, and it is a sight of rare beauty. The species is limited to wet lowland evergreen forest but is not usually found where rainfall is much less than 4000 mm a year, and it seems unable to survive in severely disturbed forest. On the Kanara Ghats, however, where paddy fields are interspersed with primary forest, the Buddha Peacock emerges from the forest to feed on *Lantana* and on *Clerodendron paniculatum*. The latter plant is also a great favourite of the Purplebacked Sunbird, which attacks the Buddha in the belief that the butterfly is a supernormal rival, since the green colour of Buddha matches the green crown and the wing shoulders of the bird (Larsen 1987c). Normally the butterfly flies in dense forest at canopy level with a furious flight and is almost impossible to net except when visiting flowers. There are no records from damp patches, though *P. crino* is an avid mudpuddler. In the Nilgiris it is limited to the western slopes and though not uncommon is difficult to collect. It is more common in Kanara. The chief season is just after the end of the SW monsoon in late September and early October, but individuals may be met with at any time. Bell *et al.* have data on diapause in Kanara. It should be mentioned that Gordon Thompson once caught a male at Glenburn, an illustration of the potential dispersal power of such a strong butterfly. I have given a more detailed account on the ecology and habits of this species elsewhere (Larsen 1987).

LEPTOCIRCINI

015. **Graphium sarpedon teredon** Felder & Felder
(*Zetides sarpedon*)

The COMMON BLUEBOTTLE is a genuinely common butterfly in the Nilgiris from the lowest levels to the highest peaks, and it is the one species able to colonise agricultural lands. However, it will not survive permanently in the driest tracts. It is an avid visitor to both flowers and damp patches, but at lower levels it is often outnumbered by *G. doson*. By disposition it is a very nervous insect and is not easy to catch. More than most swallowtails it is attracted to natural baits such as rotting grasshoppers and cicadas. I have found the larva on *Cinnamonum*, but it feeds on numerous other plants as well. The world-wide distribution covers practically all of the Oriental region.

016. **Graphium doson eleius** Fruhstorfer
(*Zetides doson*)

The COMMON JAY is essentially a butterfly of the evergreen forest zone at both tropical and subtropical levels, but it is occasionally found away from forest proper. At low levels in evergreen forest it is sometimes more numerous than is *G. sarpedon*. Large numbers may be seen mudpuddling just before the onset of the SW monsoon, and when the monsoon changes in Sep./Oct. My childhood records indicate that we did occasionally see it as high as 2000 m, but this is exceptional. The world-wide distribution covers Sri Lanka and southern India, suitable spots of the Eastern Ghats, and then most of the Oriental region.

017. **Graphium agamemnon menides** Felder & Felder
(*Zetides agamemnon*)

The TAILED JAY with its apple green markings is among the more attractive Nilgiri butterflies, but on the whole it is less common than the previous two members of the genus. Its relative scarcity is a bit surprising since it is common in cities such as Mysore, Bangalore and Madras. It is absent from the very driest tracts and not normally resident on the plateau, though it may breed there during summer. While it is an avid visitor to flowers

it is much less of a compulsive mudpuddler than the two preceding species. The global distribution covers the entire Oriental region.

018. **Pathysa nomius nomius** Esper

The SPOT SWORDTAIL may be very common during the dry season at the foot of the Kotagiri Ghat and at Kallar, but it is rare elsewhere and at any other time. It seems to be a species of dry mixed deciduous forest, sharing this habitat with *Papilio crino*. Just as the latter species has hardly any overlap with *Papilio buddha*, so *P. nomius* hardly overlaps with the rainforest species *P. antipathes*. Hampson caught only a few specimens on the northern slopes, and on the Nadgani Ghat I have only caught one, though *P. antipathes* may be common indeed. Normally the species flies high and fast, but in spring (March to early June) it is an avid visitor to damp patches. It is a migrant and specimens are seen on the plateau from time to time, but it does not breed there. The global distribution covers virtually the entire Oriental region. I agree with Eliot (1978) that it is legitimate to maintain the generic name *Pathysa* for the Swordtails, rather than to subsume them under *Graphium*.

019. **Pathysa antipathes alcibiades** Fabricius

The FIVE BAR SWORDTAIL is a dramatic insect that is limited to the wettest rainforests of southern India and Sri Lanka. Generally it is considered to be scarce, but in the right spots it may actually be very common indeed. The flight is fast and furious, and when on the wing the butterfly looks more like a fast Pierid than like a swallowtail. During February/March, the main season, it is an inveterate mudpuddler. When disturbed on a mud patch specimens will often perch on vegetation close by. It is reputed to visit flowers but I have never personally witnessed this. The species is found in Sri Lanka, S. India, then again from Nepal east to most of the Oriental region. The South Indian subspecies has usually been referred to as ssp. *naira* Moore. However, Fabricius described ssp. *alcibiades* after specimens from 'Tranquebar', then a Danish colony and examination of the Fabrician types in Copenhagen by Harish Gaonkar clearly show them to be of South Indian origin (though Tranquebar cannot be the correct locality).

PIERIDAE

PIERINAE

020. **Delias eucharis** Drury

The COMMON JEZEBEL is one of the most striking Indian butterflies and it is generally not rare, occasionally being locally abundant. It may be found practically everywhere in the Nilgiris, and it seems that the absence of frost and the presence of the larval food plant, *Loranthus* are the only ecological requirements. The adult butterfly is very fond of Lantana flowers, but unlike the montane members of the genus in Papua New Guinea it is not attracted to water. The species is endemic to India and Sri Lanka and unlike other members of the genus which are forest dwellers, *D. eucharis* is common even in major towns and cities. This trait is shared with *D. hyparete* Linné which replaces it from Burma eastwards. When handled the species feigns death and it is almost certainly aposematic. In *Prioneris sita* it has a beautiful mimic.

021. **Leptosia nina nina** Fabricius

The PSYCHE is the only Oriental representative of an African genus with half a score or so of very similar species. Eliot (1978) suggests that the Oriental species might be conspecific with the African *L. alcesta* but this seems unlikely in view of significant differences in haploid chromosome numbers (n=19 in *nina* and n=12 in *alcesta*). The species is very common all year at Kallar but otherwise

it appears to be remarkably scarce in the Nilgiris, though I have found it as high as 1900 m near Kotagiri in the 1950ies. It seems to avoid the wettest of the evergreen forests and I have not come across it at Nadgani. The flight is weak and fluttering, probably the most feeble of any South Indian butterfly. Flowers are visited, with *Tridax* as a firm favourite, while water is only occasionally attractive. I have once seen an African member of the genus actually alight on a pool of water. The species is distributed throughout the Oriental region.

022. **Prioneris sita** Felder & Felder

The PAINTED SAWTOOTH is not rare on the western slopes of the Nilgiris and on occasion it may be very common on the Nadgani Ghat during the dry season when large numbers are to be found on damp patches in the company of *Graphium doson* and *Pathysa antipathes.* It is distinctly uncommon during the rainy season and is only very rarely found outside of the wettest evergreen forest zone. I have taken a male (23.v) and a female (4.vi) at Kallar, but this is most exceptional. Both sexes are excellent mimics of *Delias eucharis,* a butterfly with a much wider range. The male, it is true, sometimes flies much faster than the model, in the manner of *Hebomoia glaucippe,* but at other times, such as when circling round a damp patch, the flight is quite like that of the Jezebel model. The species is endemic to Sri Lanka and the Western Ghats system.

023. **Artogeia canidia canis** Evans
(*Pieris canidia*)

The INDIAN CABBAGE WHITE is a Palaearctic butterfly that is very common on the plateau above 1800 m, flying in a series of broods throughout the year. The original habitat must have been the edges of sholas, but it is now especially common in agricultural areas where it is a moderately serious pest of cabbages. In northern India the species is migratory and visits the plains in winter (Larsen 1986a), but I have seen no evidence of migration in the Nilgiris. The Bangalore record that so puzzled Wynter-Blyth (1957) probably came as a pupa with agricultural produce. The butterfly spends most of its time flying around in search of flowers and will occasionally visit damp patches on hot, dry days. It is found on the higher South Indian mountains but is absent from Sri Lanka. In all probability the total area above 1900 m on that island was too small to support a viable population. Outside of South India it is found from the Himalaya east to Japan, just penetrating the tropics in suitable localities.

024. **Cepora nerissa phryne** Fabricius
(*Huphina nerissa*)

The COMMON GULL is chiefly a butterfly of the drier lowland habitats, though it may be found in clearings at middle heights. Mixed deciduous forest, ill-kept agricultural land, and thorn forest are the main haunts of this generally common butterfly. Due to strong migratory tendencies it is also met with on the plateau from time to time but I cannot agree with Wynter-Blyth (1946, 1957) that it is resident much above 1400 m. In spring large numbers may be seen mudpuddling with other Pierids. In behaviour it is more or less a tropical replacement for the Small Cabbage White (*Artogeia rapae*) and it is much less of a quarrelsome species than the two *Ixias.* The distribution covers practically the entire Oriental region.

025. **Cepora nadina remba** Moore
(*Huphina nadina*)

The LESSER GULL is limited to the wetter parts of lowland evergreen forest and is never seen in open country. Hampson noted that

it was sometimes common, but generally it is uncommon. Usually only single specimens are met with. It spends most of its time flying in the forest where it is almost impossible to collect, but one or two can usually be found on a good mudpuddling patch and occasionally on flowers. Its behaviour and general aspect in nature contrast so strongly with those of *C. nerissa* that it is difficult to accept them as congeneric. Apart from in Sri Lanka and South India the species is found from Nepal east to Taiwan and Sumatra.

026. **Anaphaeis aurota** Fabricius

The CAPER WHITE is linked to the drier tropical habitats, but owing to a great migratory potential it may occasionally be found in numbers practically anywhere. Vast swarms are sometimes encountered and, like many migrants, numbers fluctuate considerably in a most unpredictable way. In the Nilgiris it is most consistently common in the thorn forests around Masinagudi. Under good conditions this butterfly breeds faster and more profusely than practically any other and it may completely strip all available food plants for miles around. The species is Palaeotropical, being found on the Indian subcontinent, Arabia and all over Africa. It occasionally invades the Mediterranean area (Larsen 1986b).

027. **Appias indra shiva** Swinhoe

The PLAIN PUFFIN is a rather scarce butterfly that seems to be centred on the subtropical evergreen forest zone, though it may be found both below and above this level. There are few Nilgiri records. I took one at Tamizagham in Ooty (ii.1984) and it seems to have a headquarters of sorts on the Coonoor Ghat between Wenlock Bridge and Benhope where Wynter-Blyth caught most of his material and where I have seen it on several occasions. I have seen it once only at Kallar (31.viii) and Gordon Thompson has a few taken at water on the Nadgani Ghat where I never saw it. No clear pattern emerges. It comes freely to flowers. In Sri Lanka the species is considered even more of a rarity than is the case in South India. Otherwise it ranges from Nepal east to most of the Oriental region where it is often common.

028. **Appias libythea libythea** Fabricius

The name STRIPED ALBATROSS is something of a misnomer for the South Indian population where the males are practically immaculate except for some dark apical shading. The underside of the hindwing is chalky white lacking the cream overlay of the otherwise similar *A. albina.* A certain distinction between these two species lies in the cell of the forewings. *A. libythea* has the end cell vein forming a 90° angle to the costal edge, while in other *Appias* the angle is only 30°. Hampson considered it to be a rare species while Wynter-Blyth failed to find it. I have taken it on the Kotagiri Ghat, at Glenburn, Kallar, Ronningtown and even on Nadgani Ghat. It appears to be most unpredictable, possibly because it is migratory, but its headquarters are probably the mixed deciduous forests, though it might be without a permanent headquarters. It is certainly most erratic in the Delhi area (Larsen 1987b). The range covers Sri Lanka and India, east to the Philippines and Malaysia. Numbers have increased significantly in Malaysia this century (Eliot 1978) probably because the butterfly does well in secondary vegetation in the wetter tropics.

029. **Appias lyncida latifascia** Moore

The CHOCOLATE ALBATROSS is easily recognised by the deep yellow colour of the hindwing underside and the broad chocolate borders. These are not obscured by the considerable level of individual and seasonal variation. I find it a most enigmatic butterfly in the Nilgiris, difficult to interpret in ecolo-

gical and distributional terms. Hampson records it simply in the words '1000 to 3000 ft'. Wynter-Blyth took only three at Kallar, commenting that it was reputed to be common on the Kotagiri Ghat, where I never saw it. On 1.v and 2.v I saw single males flying towards the SW in Kotagiri town in the manner of normal migrants. I have seen small numbers on about half of my visits to Nadgani Ghat, where it sometimes came to water. Four were collected in mixed deciduous forest at Ronningtown. This is a pattern singularly lacking in consistency. The worldwide distribution covers Sri Lanka, the Western Ghats, and then from Nepal east to most of the Oriental region. An apparently isolated population exists in Orissa.

030. **Appias albina darada** Felder & Felder

The COMMON ALBATROSS is indeed the most common of the Nilgiri *Appias,* but like other members of the genus it is somewhat unpredictable. I would not, however, concur with Wynter-Blyth's statement that it is 'most abundant everywhere'. I have taken specimens in most of the localities visited from time to time, though this species will not be found in the drier lowland forests where *A. libythea* may be met with. The headquarters appears to be in the drier parts of the lowland evergreen forest where it merges with the mixed deciduous. It may be caught at flowers but more usually at damp patches. In the large migration that took place in late May and early June of 1986 (Larsen 1987b) this species contributed less than 0.5% of the total (some 20.000 individuals). In the migrations of my childhood (Larsen 1978a) there were millions. It ranges from Sri Lanka and the Western Ghats, through suitable places in peninsular India to Sikkim, and from there east to practically the entire Oriental region, New Guinea and NE Australia.

031. **Appias wardii** Moore

The LESSER ALBATROSS is inappropriately named since males are usually larger and more dramatically marked with black than those of the other species of the genus. The taxonomy of this and related species is difficult. There is something to be said for uniting the large number of often disjunct and distinctive taxa under the '*paulina*' umbrella, but the South Indian form is so different from the Sri Lankan that specific status seems the best solution till a full revision of the species-group has taken place. In the wet season form the South Indian taxon is easily identified since it has the black markings normally characteristic of female *A. albina.* The dry season forms are very similar to male *A. albina,* though vestiges of the black apical markings sometimes remain. Hampson confused the genus so thoroughly that whether he obtained this species or not is uncertain. Wynter-Blyth did not mention it in his main Nilgiri paper. I have caught it on several occasions at Glenburn, once near Naduvattam, and on a few occasions at Nadgani. It is decidedly uncommon. The range is similar to that of *A. albina,* but the species is much less common, confined to dense evergreen forest, and populations are often disjunct.

032. **Colotis amata amata** Fabricius
(*Colotis calais*)

The South Indian subspecies of the SMALL SALMON ARAB has traditionally been known as ssp. *modesta* Butler, but the Fabrician type is from South India and has been checked by Harish Gaonkar. At best the name *modesta* is applicable to the Sri Lankan population, but that hardly merits a name of its own. From North India and west through Arabia and the African Sahel it flies in the very different ssp. *calais* Cramer. The Small Salmon Arab is chiefly found in the thorn forest formations and surrounding agricultural land, though I

have seen specimens also in the mixed deciduous forest of the Kotagiri Ghat. The South and Central Indian subspecies is very different from the North Indian and African one, and its main food plant seems to be *Azima* rather than the more normal *Salvadora.* There might be a case for considering the two taxa specifically distinct, and certainly the presence of the two subspecies in India would appear to be due to a multiple invasion from Africa. In the Nilgiris area the species is quite localised but usually common where found, often in the company of the other *Colotis* species. The distribution covers all of tropical Africa, much of Arabia, the drier parts of the Indian subcontinent. and NE Sri Lanka.

033. **Colotis etrida** Boisduval

The SMALL ORANGE TIP is a common butterfly in the drier lowland habitats, but it pushes further up the mountain and further into the wetter zones than do the other members of genus. There is a considerable degree of individual and seasonal variation, and the species is often wholly absent during the wettest months of the year. Occasional specimens are met with on the plateau indicating some capacity for dispersal. The butterfly comes avidly to flowers, especially *Tridax,* but neither this nor other members of the genus come to water, despite being found in very dry habitats. The genus is African, but the species is endemic to Sri Lanka and the Indian peninsula.

034. **Colotis eucharis eucharis** Fabricius

The PLAIN ORANGE TIP is a fairly local butterfly, but it is usually not rare where its food plant, *Cadaba indica* grows. This is normally on rocky ground in the thorn forest of the foothills, or along the hedges growing at the edge of fields. It is almost invariably found in the company of *Colotis danae* with which it shares the larval food plant. Usually most of their time is spent flying about stands of *Cadaba* in search of partners, but they will feed from flowers. On exceptionally hot days the warmest hours are spent in the shade of dense trees, usually right down amongst the roots. The species is an intruder from the Afrotropical region, where it is found throughout the tropical zone. In India it is limited to the Deccan and southern India, being found in NE Sri Lanka as well, but not in Sind and Saurashtra where the Afrotropical species usually occur. This is a classical Sudano-Deccanian distribution pattern.

035. **Colotis danae danae** Fabricius

In South India CRIMSON TIP butterfly is quite parallel in distribution and habits to *Colotis eucharis* but it is rather more common. If only one of the species is present it is almost invariably *C. danae.* The nominate subspecies is found on Sri Lanka and in peninsular India as far north as Madhya Pradesh. A different subspecies inhabits the area from Saurashtra to Baluchistan. Usually known as ssp. *dulcis* Butler, I find it impossible to separate it from the Arabian ssp. *eupompe* Klug. Different subspecies are found throughout dry, tropical Africa.

036. **Madais fausta fulvia** Wallengren
(*Colotis fausta*)

The SALMON ARAB is a pretty and vivacious butterfly of the drier foothills where it may be, on occasion, quite common. It penetrates higher up the mountains and deeper into the evergreen forests than most of the related *Colotis* species. The flight is rapid and dancing and it is often difficult to capture a good series of specimens. As elsewhere in India, the larval food plants are *Maerua,* though the nominate subspecies from the Middle East feeds on *Capparis* as well. The species visits flowers freely, not least *Tridax,* but never comes to damp patches. The subspecies from

peninsular India differs from the others through invariably having white females. In northern India ssp. *fulvia* has dimorphic females, while in the nominate subspecies all females are salmon. The Indian populations appear to be highly sedentary though the nominate subspecies in Arabia and the Middle East is strongly migratory. The genus is monobasic, very close to *Colotis,* and the single species is found in Arabia, the Middle East and the Indian subcontinent, just penetrating the East African coastal regions north of Kenya.

037. **Ixias marianne** Cramer

The two Indian *Ixias* are almost identical in distribution and habits, though in most of India the WHITE ORANGE TIP, *I. marianne,* is slightly less common than *I. pyrene.* They are both common in the mixed deciduous forest, in thorn forest and in ill-kept agricultural land at low levels. There is little penetration into the subtropical zone, nor into the lowland evergreen forests. In May and June both are among the most prominent species in the mud-puddling assemblages, and both were prominent in the large migration that I observed in late May and early June (Larsen 1987b). Normally the butterflies are seen flying about the open scrubland in search of flowers, mates or food plants. *I. marianne* is endemic to India and Sri Lanka.

038. **Ixias pyrene sesia** Fabricius

The use of subspecific names for the YELLOW ORANGE TIP in India has been the subject of some confusion. I follow Gabriel (1943) in using the name *sesia.* There is, in any case, so much seasonal and individual variation that the designation of subspecies is difficult. The habits are like those of the preceding species and were the ground colour of the two not different they would be impossible to distinguish in the field. The range stretches from Sri Lanka, throughout India east to Hong Kong and Malaysia.

039. **Hebomoia glaucippe australis** Butler.

The GIANT ORANGE TIP is one of my favourite butterflies. It is the largest of the Indian Pierids, and it is a beautiful sight to see it swooping down the mountains along densely clad water courses with the wings held three-fourths open. It is generally common enough in mixed deciduous and open evergreen forest at low levels, sometimes being found also in subtropical evergreen forest. It is not a good coloniser of agricultural land and is rarely found in disturbed areas. It comes to flowers but is then very wary. Often it hovers on the flower in the manner of the Papilionidae, the only Pierid to do so. The species is an avid mudpuddler actively following river systems on the look-out for good spots which may well be situated some distance from the forest edge. In the afternoon they may be seen moving up-river again. When mudpuddling, together with myriads of other Pierids and some Papilionids, the camouflage pattern of the underside may be seen at its best. Never mind how carefully you study the assemblage, one or two *H. glaucippe* will be overlooked. The larva is a startlingly effective snake mimic. When handled it rears up its head, revealing a couple of blue eye-spots that are concealed when the larva is at rest. Most likely this is a defence against the Bonnet Macaque Monkey whose instinctive fear of snakes is almost comical in its manifestations (try throwing a little bit of rope out of a car and watch the results). The species is distributed in suitable country throughout the Oriental region.

040. **Pareronia valeria hippia** Fabricius
(*Parenonia* (*sic*!) *valeria*)

The COMMON WANDERER appears to be very rare in the Nilgiris. Hampson mentions it with

no detail, Wynter-Blyth and I failed to find it, though there is a genuine specimen from Kallar in the Bombay Natural History Society collections. This scarcity is difficult to understand as it is common enough in forested country around Bangalore and as the forests on the northern slopes seem very suitable for the species. It is worth mentioning that the South Indian population throws up the occasional female of the form mimicking *Parantica aspasia* Fabricius, a Danaid that does not occur in peninsular India. The species is not found in Sri Lanka, but stretches from India deep into the Oriental region.

041. **Pareronia ceylonica** Felder & Felder
(*Parenonia* (*sic!*) *ceylonica*)

The DARK WANDERER is endemic to Sri Lanka and southern India where it is more of a wet zone butterfly than is the preceding species. The South Indian population is listed as ssp. *pingasa* Moore by d'Abrera, but I agree with Talbot that it is not worthwhile separating it from the nominate Sri Lankan. It will be found in the mixed deciduous forests as well as in tropical evergreen at Nadgani. It is normally somewhat scarce but may be quite common at Kallar. The flight is fast and restless through dense vegetation and even when coming to flowers it is wary, so procuring a good series is not always easy. I have never seen it at water, though I have seen a picture of one of the *Pareronia* in a mudpuddling assemblage. On the wing the female is a most effective mimic of *Parantica aglea*, very much more so than one would suspect from cabinet specimens.

COLIADINAE

042. **Catopsilia pomona** Fabricius
(*C. pomona* & *crocale*)

The LEMON EMIGRANT is a large and powerful butterfly that is strongly migratory. Almost a million participated in the relatively modest migration that I documented in May/June of 1986 (Larsen 1987b), and many millions were involved in a month or more of intermittent, generally southwards migration during September and October. Its main base is the drier lowland formations, but it can be found breeding practically anywhere except on the highest plateau. It is an avid mudpuddler and has a great liking for flowers. There are two chief forms: f. *crocale* has black antennae and has immaculate undersides; f. *pomona* has reddish antennae and the underside has dark irroration as well as spots at the end of the cell. Intermediates are found but they are not very common. There is no doubt that they represent forms of one species, but the relative frequency of the two forms varies and their respective functions are quite unknown. The large numbers that settled on damp patches at Kallar in May 1986 were 95% *crocale*, while during the wet season the two forms were roughly equal in number. Both forms participate in the migrations so we are not faced with the type of phases so well known from migratory locusts. A thorough study of the dimorphism in this species would be most interesting. The range covers the entire Oriental region, New Guinea, parts of Australia to well out in the Pacific. A Malagasy species (*Catopsilia thaurama* Reakirt) is sometimes, in my view not correctly, linked to *C. pomona*.

043. **Catopsilia pyranthe** Linné
(*C. pyranthe* & *C. florella*)

The MOTTLED EMIGRANT is a common butterfly with both sexes showing a high degree of variation. The *florella* form with very narrow forewing borders and with well-developed, red-ringed silver spots at the end cell of the underside has traditionally been accorded specific status, especially since it is relatively constant in Africa, while the *pyranthe* form is fairly constant in eastern Asia. However,

in India's drier tracts both forms and intermediates occur with little consistency, except that the *florella* form is most frequent during the dry season. The species is common in the Nilgiris, sometimes very much so, usually in the *pyranthe* morph. The species is strongly migratory and the progeny of migrants sometimes breed even on the plateau, though it is mainly a species of the lowland drier tracts. It is fond of both flowers and damp patches. The distribution covers all of tropical Africa, southern Arabia, the entire Oriental region, New Guinea and parts of Australia.

044. **Eurema brigitta rubella** Wallace
(*Terias libythea*)

The SMALL YELLOW is a common butterfly with the widest possible of distributions, both geographically and ecologically. In the Nilgiris it may be found at all levels in most types of habitat, though it tends to avoid the dense evergreen forests. It is, in fact, one of those butterflies that seem to thrive particularly well in areas disturbed by the activities of man. It is not very common and somewhat local in the Nilgiris. Flowers are avidly visited, but the species is rarely seen at damp patches. It has been known to migrate but I have seen no evidence of this in the Nilgiris. *E. brigitta* was one of the few permanent residents of my compound in Kotagiri, the population usually consisting of four to eights individuals at any given time. One specimen was seen captured in flight and eaten by the Whitespotted Fantail Flycatcher (*Rhipidura albicollis*). The range covers all of tropical Africa, southwestern Arabia, most of the Oriental region and parts of New Guinea and Australia. From Sundaland eastwards it becomes a rather scarce and local grasslands species, possibly because of competition from the many other members of the genus in that area (Holloway 1973 gives an interesting review of the genus).

045. **Eurema laeta laeta** Boisduval
(*Terias laeta*)

The SPOTLESS GRASS YELLOW is normally a common species, but on the whole this is not the case in the Nilgiris. Wynter-Blyth was a long time before finding it in numbers near Coonoor and at Gudalur. I have found only modest colonies in one or two places on the Nadgani Ghat and at Masinagudi. Obviously colonies may be found in nearly all types of terrain. There is strong seasonal dimorphism, but I have seen only wet season forms in the Nilgiris. The species has a limited distribution compared to some of the other *Eurema*, being found only in Sri Lanka and from India to Burma, Thailand and Indo-China.

046. **Eurema hecabe simulata** Moore
(*Terias hecabe*)

The COMMON GRASS YELLOW is just that, very common practically everywhere. Since it also has a vast range it is probably among the top ten of the world's most numerous butterflies. In the Nilgiris it may be found literally anywhere, though it is least common in dense evergreen forest where it is replaced by *E. blanda*. Indeed, *E. hecabe* is often particularly common in habitats that have been modified by human activity. The species is a known migrant, but large scale migration has not been observed in the Nilgiris, though some did follow the May 1986 migration (Larsen 1987b). It visits flowers and often comes to damp patches. The range covers the entire old world tropical zone from Africa and Arabia to India and the Oriental region, to New Guinea, Australia, Japan, Fiji and Tonga.

047. **Eurema blanda silhetana** Wallace
(*Terias blanda*)

The THREE SPOT GRASS YELLOW is restricted to lowland forests where it is sometimes very common indeed. The flight is often higher

above the ground than in the other species of the genus, probably because the larval food plants are tall trees like *Albizzia* and associated creepers like *Wagatea spicata.* Contrary to the other *Eurema* the present species lays its eggs in large batches and the larvae and the pupae are gregarious throughout, the black pupae being situated so close to each other as to almost touch, sometimes up to fifty at a time. The species may assume pest proportions in *Albizzia* plantations. *E. blanda* is found in Sri Lanka, South India's wetter tracts, Eastern Ghats and then east to practically all the Oriental region to at least Papua New Guinea.

048. **Eurema andersonii ormistoni** Watkins (*Terias andersoni*)

The ONE SPOT GRASS YELLOW is the odd man out among the South Indian *Eurema* inasmuch as it is a genuinely rare and local species. In the Nilgiris it seems limited to evergreen tropical forest below 1500 m, which means that it just penetrates the subtropical level. Wynter-Blyth collected a few at Kallar where I have also taken the species. I also have a few from the Glenburn forests as well as one from an evergreen patch on the Kotagiri Ghat. The flight is weak and irresolute, the butterfly coming to both flowers and wet patches. It occurs from Sri Lanka through suitable wet tracts of peninsular India to Malaysia, and it seems to be scarce and local everywhere.

049. **Colias nilagiriensis** Felder & Felder (*Colias erate*)

The NILGIRI CLOUDED YELLOW is quite common on the plateau above 1900 m, flying throughout the year, especially in places with some moisture. The biggest concentration I have seen is in the beautiful bog at Longwood Shola near Kotagiri where hundreds may be seen on a good day, buzzing about just above the surface. The larval food plant here is *Parochetus communis*, though I suspect other plants are used elsewhere. All South Indian females of this butterfly are white, though in all its closest relatives females occur in both white and yellow forms. While related to the Palaearctic *C. erate* Esper I can see little reason for not accepting the isolated and morphologically very distinctive South Indian taxon as specifically distinct. As such it is a South Indian endemic species of obvious Palaearctic origin.

(*to be continued*)

NOTES ON COMPARATIVE BODY SIZE, REPRODUCTIVE EFFORT AND AREAS OF MANAGEMENT PRIORITY FOR THREE SPECIES OF *KACHUGA* (REPTILIA, CHELONIA) IN THE NATIONAL CHAMBAL SANCTUARY[1]

R. J. RAO[2] AND L. A. K. SINGH[3]

(*With a plate & three text-figures*)

Record lengths of carapace have been reported from the River Chambal for *Kachuga tentoria circumdata* (26.5 cm), *K. dhongoka* (48.0 cm) and *K. kachuga* (49.0 cm). The ratios, carapace length/breadth and plastron length/breadth were similar in all three species. The ratio carapace length/shell height was less in *K. tentoria* as it bears a high dome. Out of 13 areas of nesting identified for management-priority, 23.0% were shared by all three species and 46.1% by *K. tentoria* and *K. dhongoka*. Although biometrical features relating 'body capacity' to 'egg mass occupancy' in the body indicate similarities between *K. tentoria* and *K. kachuga,* only *K. tentotia* is known to lay more than one clutch per season while others lay only one. The incubation period is 5-8 months for *tentoria* as winter-laying is there, but is 2 months for the others. The clutch sizes are 4-9 (*tentoria*), 21-35 (*dhongoka*) and 11-18 (*kachuga*). Egg length × breadth cm × weight g are: 4.7 × 2.7 × 21.4 (*tentoria*), 5.9 × 3.6 × 44.2 (*dhongoka*) and 7.0 × 4.1 × 57.4 (*kachuga*).

INTRODUCTION

Three species of *Kachuga* (Emydidae) namely, *K. tentoria circumdata, K. dhongoka* and *K. kachuga* occur in the National Chambal Sanctuary along the River Chambal of the Gangetic system (Rao and Singh *in press*). In the following we present data on the body size of these chelonians with preliminary analysis of the observations on their reproduction. Besides, a list is given of the nesting areas that are of significance to a Manager for the species in the Sanctuary.

The National Chambal Sanctuary, created in 1978 extends from Jawaharsagar Dam (Rajasthan) to Kota barrage (Rajasthan) and after a gap of 18 km, from Keshoraipatan (Rajasthan) through Pali (M.P./Rajasthan) to Pachhnada (Uttar Pradesh). The total length of the river inside the Sanctuary is about 600 km.

MATERIALS AND METHODS

Three live and 22 caracases of *K. t. circumdata* and three caracases each of *K. dhongoka* and *K. kachuga* were collected outside water during survey trips made by boat and foot between October 1983 and July 1984. The shell measurements of all specimens were taken as described by McRae *et al.* (1981) and the data were used to compare the maximum sizes reported in literature for different species (Smith 1933, Pritchard 1979, and Daniel 1983), and determine the similarities in certain biometrical ratios. The carapace

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length and carapace width (=plastron width) were taken as straightline measurements.

Four gravid females, represented by two of *tentoria* and one from each of the two other species were examined at the ovary (for methods see, Moll and Legler 1971. Rao 1982) to determine the nesting frequency and collect comparative data on clutch and egg sizes in relation to the length of the females.

In order to compare the species-wise reproductive effort, the approximate body capacities (BV) have been considered against the approximate egg-clutch mass (EM) and egg-clutch occupancy (EV). The following methods were used in calculating BV, EM and EV.

$$BV = \frac{PL \times PB \times SH,}{2},$$

$$EM = CS \times EW, \text{ and } EV = CS \times EL \times EB$$

In the above, PL and PB are the mean lengths and breadths of plastron, SH, the mean shell height; CS, the mean clutch size (mean number of eggs per clutch); EL and EB, the mean length and breadth of eggs, and EW the mean egg weight (g). All measurements are in centimetres.

The incubation period was determined by direct corroboration of nesting activities, period of commencement of embryonic development and periods of sightings of hatchlings.

Different nesting areas and their management priorities were determined during the surveys from the extent of nesting activities and predation pressure.

Results

Size and biometrical ratios. The average shell measurements of dead and live specimens of hardshelled turtles collected in the Chambal river are presented in Table 1. The mean carapace lengths were 24.65 cm (*Kachuga tentoria circumdata*), 44.6 cm. (*K. dhongoka*) and 47.6 cm (*K. kachuga*). The maximum length of the carapace in the three species were 26.5 cm, 48.0 cm and 49.0 cm, respectively. The plastron was always smaller than the carapace but attached to the latter at such a point in the front that it protruded out a little behind the rear end of the carapace. Therefore, the total lengths (Table 1) were larger than the carapace length. The ratios carapace length/width were 1.38, 1.38 and 1.32 for *K. tentoria circumdata, K. dhongoka* and *K. kachuga* respectively (Table 1). The ratio, plastron length/width were 1.26, 1.27 and 1.25 respectively and the ratio, carapace length/shell height (body depth) were 2.24, 2.73 and 2.34. For one male *K. kachuga* the ratios were: carapace length/width 1.25, plastron length/width 1.14 and carapace length/shell height 2.36. The male (29.5 cm carapace length) was caught by net near Babu Singh ka gher (Table 2) on 5 December 1983. The turtle, being in its breeding colours, had six red longitudinal stripes along the neck, a pair of oblong yellow spots on the throat and the head was brilliantly red on the top and bluish on the sides.

Nesting areas, Distribution pattern. *Kachuga* are very scarce in the river upstream of Pali. Downstream of Pali although pre-nesting activities were seen, no nests were located. The first major nesting site was located at Baroli (Table 2), 57 km downstream of Pali.

Out of the total 13 identified nesting sites (Table 2) three (23.0%) were common to all three species, and six (46.1%) were common to *K. tentoria* and *K. dhongoka.* There were no regular distance-intervals between any two nesting sites (Figs. 1 and 3).

Nesting frequency. Three predated nests, about a week old, discovered on 29 October 1983 were the earliest record of nesting by *Kachuga tentoria.* Fresh nests (confirmed from fresh turtle tracks) were located on 5

TABLE 1

BODY AND EGG BIOMETRICS OF *Kachuga tentoria circumdata, K. dhongoka* and *K. kachuga*. FOR SL. NO. 1 THROUGH 8 n = 25 (*tentoria*), 3 (*dhongoka*) AND 3 (*kachuga*). SIZES IN CM AND WEIGHT IN G (RANGE IN PARENTHESES)

Sl. No.	Aspects	*K. t. circumdata*	*K. dhongoka*	*K. kachuga*
1	Carapace length CL	24.65 (22.0–26.5)	44.6 (44.0–48.0)	47.6 (46.0–49.0)
2	Carapace length in:			
(a)	Smith 1933	23.0 (*K. tectum/K. t. tentoria*)	40.0	39.0
(b)	Pritchard 1979	17.7 (7") (*K. tentoria*)	40.6 (16")	40.6 (16")
(c)	Daniel 1983	23.0 (*K. tecta/K. tentoria*)	40.0	39.0
3	Carapace width CB	17.78 (16.5–19.5)	32.3 (28.0–35.0)	36.0 (35.0–37.0)
4	Plastron length PL	22.45 (21.5–24.0)	41.16 (40.5–44.0)	45.0 (43.0–46.0)
5	Total length TL	24.8 (22.0–27.5)	44.8 (40.0–47.5)	49.3 (47.5–50.5)
6	Shell height SH	11.0 (8.0–12.5)	16.3 (15.5–17.5)	20.3 (20.0–21.0)
7	Anal width AB	4.0 (3.5–5.0)	5.3 (5.0–5.5)	6.0 (5.5–7.0)
8	Anal notch AN	3.25 (3.0–3.5)	6.6 (6.0–7.0)	6.7 (6.5–7.0)
9	CL/CB	1.38	1.38	1.32
10	PL/CB	1.26	1.27	1.25
11	CL/SH	2.24	2.73	2.34
12	Clutch size CS	5.95 (4–9) n=20	23.64 (21–35) n=31	15.5 (11–18) n=4
13	Egg length EL	4.755 (4.5–5.0) n=119	5.993 (5.18–6.62) n=220	7.049 (6.65–7.54) n=62
14	Egg width EB	2.754 (2.60–2.90) n=119	3.611 (3.20–4.12) n=220	4.161 (3.76–4.56) n=62
15	Egg weight EW	12.40 (19.8–23.3) n=119	44.21 (36.5–57.3) Mean egg weight from 22 clutches	57.42 (56.5–58.3) Mean egg weight from 4 clutches
16	BV cu. cm	2195.38	10835.16	16443.0
17	EM sq. cm g	127.33	1045.12	890.01
18	EV sq. cm	77.91	511.58	454.62
19	P_1%	5.79	9.64	5.41
20	P_2%	3.5	4.7	2.7

TABLE 2

MAJOR NESTING SITES OF *Kachuga* SP. IDENTIFIED IN NATIONAL CHAMBAL SANCTUARY, 1983-84. d, *K. dhongoka*; k, *K. kachuga* AND t, *K. tentoria circumdata*. FOR *tentoria*, **FIRST NESTING, ***SECOND NESTING. al, ALLUVIUM; bs, BUSH AND os, OPEN SAND.

Sl. No.	Location	Reference km *	River bank (M.P./U.P./ Rajasthan)	Site Description: Shore length m	Site Description: Nature of nesting ground	Species-wise use	Dates of nesting data collection
1	Baroli	57	M.P.	500	os/bs	t,d,k	1.2.84/3.4.84 ***
2	Rahu	113	M.P./Raj.	20/100	os	t	22.11.83/24.11.83**
3	Batesura	123	M.P.	100	os	t	24.11.83**
4	Bharrah	131	M.P.	500	os	t,d	6.3.84/11.3.84/ 25.3.84***
5	Devgadh (Sarsaini)	165	Raj.	250	os	t	3.11.83**
6	Basai Dang	173	Raj.	500	os	t	30.10.83**
7	Gorkha	205	Raj.	100	os	d	5.4.84
8	Tigri-Rithaura	209	Island (M.P./Raj.)	20 sq. m	al	d	29.3.84/5.4.84
9	Papripura	214	M.P.	2000	os	d	5.4.84
10	Babu Singh ka Gher	226	M.P. (Islet)	500/100 sq. m	os	t,d,k	4.12.83/26.1.84*** 30.1.84/31.1.84
11	Pureini	229	Raj.	1000	os	t,d	5.12.83/3.1.84*** 31.3.84
12	Kenjra	296	U.P.	1500	os/bs	t,d	31.1.84*** 8.4.84
13	Gyanpura	356	M.P.	200	os	t,d	2.3.84*** 13.4.84

* In reference to Palighat (Parbati-Chambal confluence) (Fig. 1).

December (10), 3 January (1) and 28 January (1). After 28 January no further nesting activities were noted. From all the above nesting records, it was presumed that nesting season of *Kachuga tentoria circumdata* extended from October through January (Fig. 2).

A female *Kachuga tentoria circumdata* (25 cm carapace length) wandering on land at 0730 hrs on 24 November contained six (3 + 3 right and left) oviductal eggs with a mean weight of 23.3 g and length × width 50±0.564 (50.0-51.5) × 29.08±0.205 (29.0-29.5) mm. The ovaries contained only six fresh corpora lutea (right 4 and left 2). Four ovarian follicles of ovulatory size (25-26 mm) were also present suggesting the production of at least two clutches per season.

On the same day (24 November) at 1600 hrs, a female turtle (carapace length 23.0 cm) was captured on land when it was returning after egg laying. The nest contained 7 eggs with the mean measurements of 46.0±0.925 (45.0-47.0) × 28.0±0.534 (27.0-29.0) mm. Mean egg weight was 22.3±0.527 (22.0-

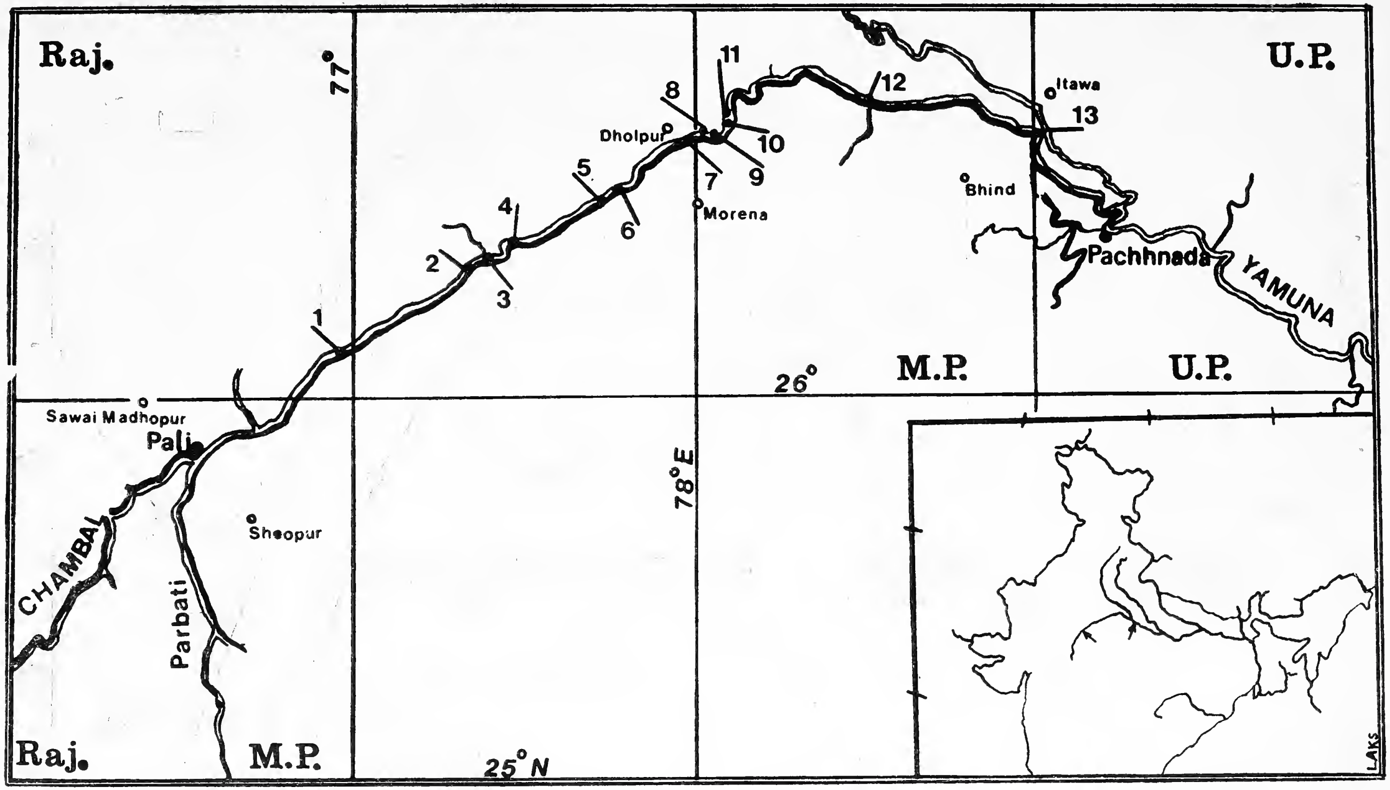


Fig. 1. River Chambal (National Chambal Sanctuary) from Pali (Chambal-Parbati confluence) to Pachhnada showing important nesting areas of *Kachuga* sp. (1-13, as in Table 2). M.P., Raj. and U.P. are the states of Madhya Pradesh, Rajasthan and Uttar Pradesh through which the river flows.

Inset: Position of River Chambal (arrows) in the Gangetic system.

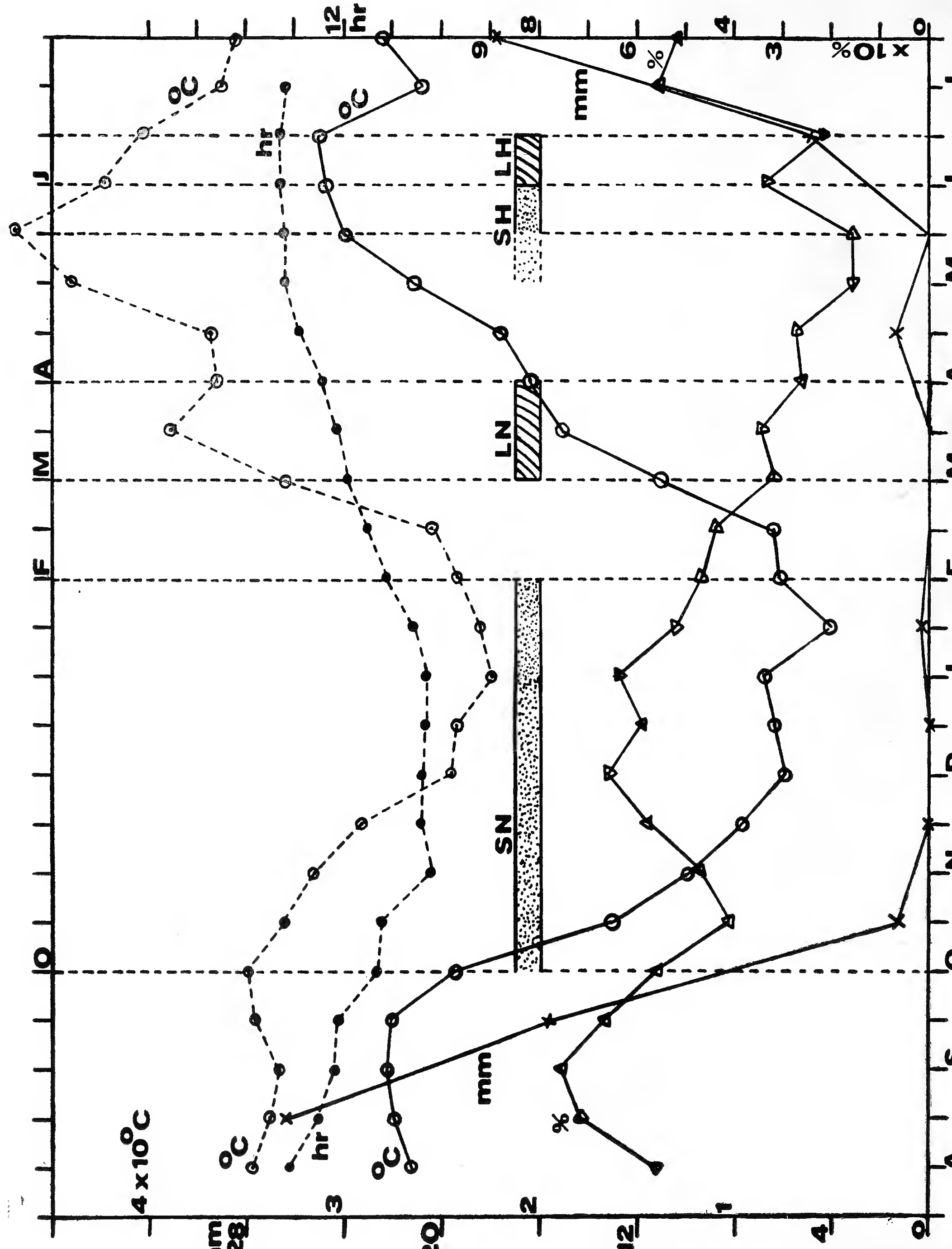


Fig. 2. Relationship among climatic conditions and breeding activities in small (S) and large (L) *Kachuga* turtles. N, nesting; H, hatching. Horizontal scale shows months from August (A) 1983 through July (J) 1984. Maximum temperature (°C) shown as dotted line and minimum temperature (°C) as solid line through hollow circles. Hour of sunshine (hr): dotted line through solid circles, relative humidity (%): solid line through hollow triangles, and rainfall (mm): solid line through crosses.

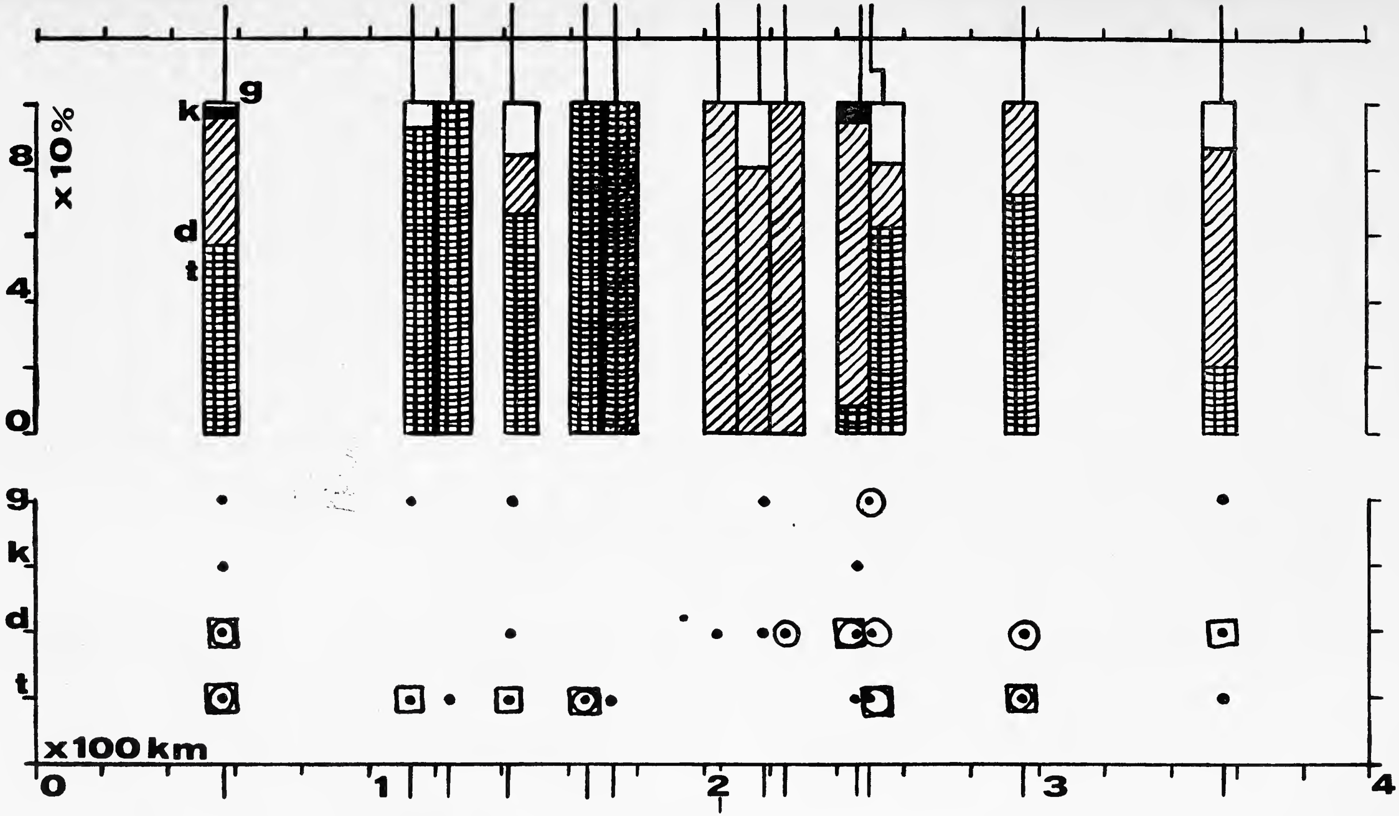


Fig. 3. Extents of nesting (lower fig.) and extents of utilisation of a nesting site in National Chambal Sanctuary during 1983-1984.
Kachuga tentoria circumdata (t, small squares);
Kachuga dhongoka (d, slanting hatch);
Kachuga kachuga (k, dark) and
Gavialis gangeticus (g, open)

In the lower figure small solid dots for 1-9 number of nests, circle with dot: 10-19 nests, square with dot: 20-29 nests, square with dotted circle: above 30 nests. Larger vertical lines over the horizontal scales of distance indicate the exact position of different nesting sites.

23.5) g. The ovaries contained seven corpora lutea (right 4 and left 3) and four ovarian follicles of ovulatory size (24-26 mm) indicating two clutches per season.

Clutch size and egg size of *Kachuga t. circumdata* are shown in Table 1. The clutch size was determined mostly from the examination of natural nests (18 no.) and also from the data on eggs found in the oviduct (n=1) of live- and in the body cavity (n=1) of dead-specimen (see above). Mean clutch size was 5.95 with a range of 4-9. Eggs were elliptical and with a very thin shell cracking to pressure. Mean egg length was 47.5 mm, width 27.54 mm and weight 21.40 g. One female *K. t. circumdata,* dead presumably a week before location (12 December 1983) had eight shelled eggs free inside the body. The female measured 26.5 cm in carapace length and the eggs 46.1 × 29.8 mm (Plate 1).

The breeding season in *K. kachuga* is expected to commence by the beginning of December because the male caught on 5 December was already in its breeding colours. The nesting season of both the large *Kachuga* sp. (*dhongoka* and *kachuga*) was March-April.

The first nest of *Kachuga dhongoka* was found on 11 March 1984 and after 31 March no fresh nesting was recorded. The nests of large *Kachuga* sp. looked the same as that of small *Kachuga* sp. except that these were of large dimension and most often on ground with relatively more silt.

Eggs in the size range of 66-75 mm in length with small clutch size (11-18) were the eggs of *Kachuga kachuga.* These eggs were 37-45 mm wide and 56-58 g in weight. Mean clutch size of *Kachuga dhongoka* was 23.64 and of *Kachuga kachuga* was 15.5. Egg dimensions and clutch size are shown in Table 1. Eggs of *K. dhongoka* were small, 51-66 mm × 32-41 mm × 36-57 g (Plate 1).

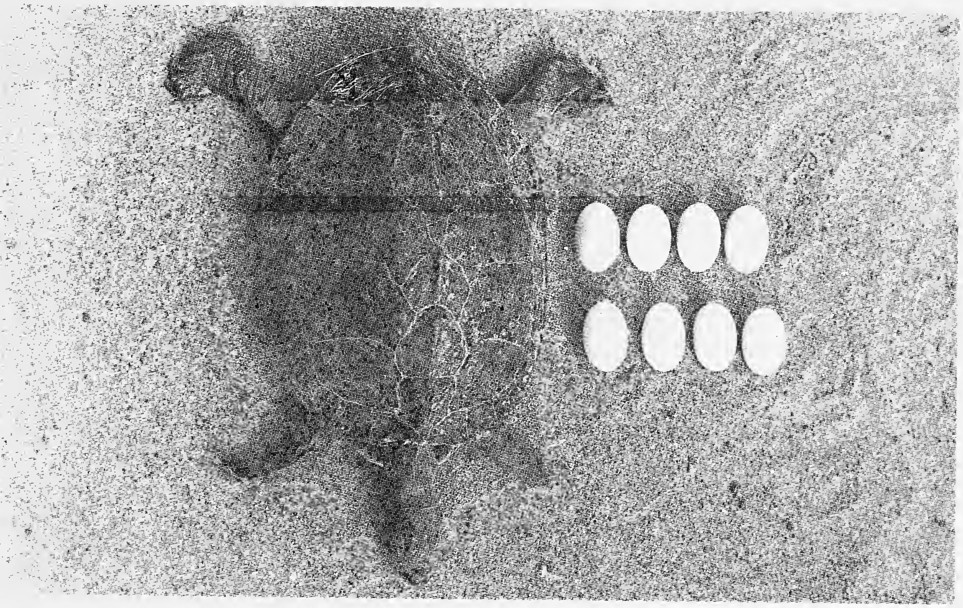
The body cavity of one *K. dhongoka* was examined late in the nesting season. The turtle was dead about a week before location (31 March 1984) and had 21 free eggs inside the body. The carapace length of the female was 40.5 cm and the eggs were 60.7 × 38.7 cm.

A *Kachuga kachuga* suspected to be dead the night before location (5.4.1984) had well calcified eggs, 4 in the right oviduct and 7 in the left. Except a few atretic follicles there were no follicles greater than 20 mm but there were 3 fresh corpora lutea in the right ovary and 8 in the left ovary. The female measured 49.0 cm in carapace length, and the eggs were 66.5 mm × 37.6 mm.

Incubation period. The minimum and maximum ambient temperature during the nesting season of *K. tentoria* (October-January) ranged as 3.5-29°C and 17-39°C, respectively (Fig. 2). The prevalent conditions of humidity, rainfall and photoperiod (sunshine) during nesting are shown in Fig. 2.

The nest temperature during winter nesting was very low (17°C-25°C) for embryo development. Periodical checks of eggs in an open hatchery revealed that there was no embryo development until March but on 3 April, 1984 (30°C nest temperature) development had already commenced. In the wild hatchlings have been seen in May.

During the nesting season of *K. dhongoka* and *K. kachuga* (March-April) the ambient temperature ranged between 11°C and 46°C (Fig. 2), and the nest temperature 27.5°C-32°C. The development of embryo was noticed to have started within two days after egg-laying. Emerged hatchlings of *K. dhongoka* were recovered from nests at Tigri-Rithaura on 4.6.1984. Nesting at Tigri-Rithaura had occurred during the last week of March. The incubation period is estimated to be about sixty days.



Above: *Kachuga tentoria circumdata* with eggs recovered from the body.
Below: A nest pit of *Kachuga dhongoka* with clutch of 23 eggs.

Comparative reproductive effort. The approximate BV of *K. tentoria, K. dhongoka* and *K. kachuga* were 2195.38, 10835.16 and 16443 respectively. The EM and EV were 127.33 and 77.91 (*K. tentoria*), 1045.12 and 511.58 (*K. dhongoka*) and 890.01 and 454.62 (*K. kachuga*) (Table 1).

The factor P_1 showing the proportion (%) of EM in BV were 5.79, 9.64 and 5.41 for *tentoria, dhongoka* and *kachuga* respectively (Table 1). The factor P_2 showing EV in BV were 3.5% (*tentoria*), 4.7% (*dhongoka*) and 2.7% (*kachuga*) (Table 1).

Discussion

The largest specimen of *K. t. circumdata, K. dhongoka* and *K. kachuga* were 26.5 cm, 48.0 cm and 49.0 cm respectively. These sizes are distinctly larger than the sizes given in literature (Table 1). We would be interested to know when larger specimens are reported.

The ratios CL/CB and PL/CB are almost the same in all three species, perhaps a basic requirement in the design of the hardshelled turtles. Differences in CL/SH are evidently due to the extent to which the dome is raised above the plastron (SH) and this makes the differences in body-capacities.

The production of multiple clutches is to be expected for forms that have less body capacity and lay only a few eggs relatively less secure. In *K. t. circumdata* the nests are 83.5% times on flat sand banks close to mainland (Rao and Singh 1984) and the clutch of 4-9 eggs are only 16.13 cm below the surface. Therefore, a double effort is made in the species to ensure enough annual recruitment after sustaining all kinds of loss. These efforts are in the number of turtles and in laying double clutches spaced over a period of few months. Singh (1985) has also reported double nesting by *K. tentoria* in Mahanadi.

In the case of *K. dhongoka* the necessity to lay more than a clutch is waived because the size of the clutch and eggs are large. *K. kachuga,* although larger in size than *K. dhongoka* and produces larger and heavier eggs, the clutch size is small. The factors P_1 and P_2 as determined by comparing the body capacities and clutch-occupancies, are closely similar in the case of *K. tentoria circumdata* and *K. kachuga* indicating that *K. kachuga* may be having the potentiality to produce more than one clutch like *K. tentoria.* If, however, the results of examination of the ovaries and oviduct in the specimen of 5.4.1984 are any indication then we can at the best conclude that between October and July *K. kachuga* lays only one clutch and it is not known if a second clutch is ever laid.

Hatchling turtles of *Chrysemys picta* and *Pseudemys scripta* (Gibbons and Nelson 1978) and *Chelydra serpentina* (Newman 1906) are known to over-winter in the nest itself, and Congdon *et al.* (1983) suspect a direct relationship between the emergence tactics of hatchlings and the level of lipid in the eggs. Singh (1985), based on his notes on terrestrial activities in *K. tentoria* of the River Mahanadi, suspected that the species perhaps hibernates. Based on the present study it is suspected that the eggs of *K. t. circumdata* laid early in the season (October) may be undergoing some development before the onset of the extremely low temperatures of December-January but during the winter, development proceeds at an extremely slow rate. The eggs laid during November and later have to remain dormant until the temperature rises to 30°C as has been observed in developing embryos of April. The above situation would lead to the hatching of *K. t. circumdata* spread over a few months that would ensure less competition. In any case, the incubation period is suspected to be 5-8

months depending on the date of egg laying and temperature. In large *Kachuga* sp. since the temperature is already high development commences soon after egg-laying. This situation calls for the greatest care in the event of a necessity to shift or translocate these eggs. More stringent than the practice with crocodilian eggs, the eggs of *K. dhongoka* and *K. kachuga* may be shifted only on the day following deposition or after 50-55 days incubation.

The reason why gravid females were dead at the nesting site without even commencing to dig a nest-pit, is difficult to explain. Egg-bound deaths are known in captive reptilians which are under stress due to lack of suitable nesting environment but why should such parallel, though stray cases, occur in nature is an aspect to study in future. At the present, these data provide stimulation to accumulate similar information to compare in future the body size to the clutch and egg sizes.

Singh (1978) has found that in the case of gharial (*Gavialis gangeticus*) even if egg sizes vary among nests there is a specific "upper-limit" to the "egg capacity" (considered as the product of egg length and breadth). In the case of the three species of *Kachuga* studied by us the egg-design is similar to the gharial's, longish with round ends, and there does appear certain extent of variation in the egg sizes within any *Kachuga* species but at present it is not known if there is an "upper limit" to the egg-capacity.

Most of the Chelonian nesting areas are either common among themselves (Table 2) or with the gharial and are under heavy predation pressure (Rao and Singh *in press*). Therefore, a Manager involved in the conservation of the gharial can, with very little extended effort, attend to the nesting areas of the turtles too. Once the action is implemented it could form the basis to take up expanded conservation management.

Acknowledgements

We express our gratitude to Government of India (Wildlife Institute of India), Food and Agriculture Organisation of the United Nations, and Government of Madhya Pradesh (Wildlife wing) for the provision of various facilities and the permission by the latter to conduct the study. Several staff members and colleagues gave assistance in the field. RJR remained a CSIR Senior Research Fellow for most part of the study duration and LAKS is with the Crocodile Research Centre of the Wildlife Institute of India.

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Note (12 June 1987): Further studies have confirmed double-nesting in *K. kachuga* between December and March.

THE GENUS *PIPER* LINN. IN KARNATAKA, INDIA[1]

B. A. Rahiman[2] and M. K. Nair[3]

(*With eight text-figures*)

The family Piperaceae, until 1940, was limited to two genera *viz.*, *Piper* Linn., and *Peperomia* Ruiz. & Pav. In 1843, F.A.W. Miquel subdivided it into several ranks and described about 600 species under 20 different segregate genera. Since then, the family has undergone considerable changes in the circumscription of various taxonomic ranks. In India, 108 species have been reported from two independent 'centres of distribution'. They are 1) the region of Sub-Himalayan and North-eastern hill ranges and 2) South Deccan. In the present paper an attempt is made, to revise the taxonomy of *Piper* species occurring in the Karnataka region of Deccan, based on the authors' survey of the region under study and collection of over 300 herbarium specimens. In all 8 species have been described. An artificial key for the Karnataka species, field notes, nomenclatural notes, comments on affinity, world distribution, distribution in India and in Karnataka and type locality are provided.

The genus *Piper* Linn., the largest in the family Piperaceae, occurs throughout the tropical and subtropical regions. More than 3000 species are on record (INDEX KEWENSIS 1895-1970, Rahiman 1983). Because of the large number of species, wide distribution, very minute, achlamydous and closely packed flowers, unisexual nature of many of the species and lack of any recent critical phyletic study (Hooker 1886; Gamble 1925; Lawrence 1951), a valid acceptable species concept could not be established till to date. Until 1940, Piperaceae was limited to two genera namely *Piper* Linn. and *Peperomia* Ruiz. & Pav. In 1843, F.A.W. Miquel in his monograph SYSTEMA PIPERACEARUM subdivided the family into several ranks such as tribe, section, cohorts, genus and species and described about 600 species of *Piper* under 20 different segregate genera. As the report of new species from all over the world accumulated and the number of species went on increasing, the segregate genera started losing their distinctions, mainly because of the lack of sharp taxonomic discontinuities within the family. In 1869, C. de Candolle in DC PRODROMUS merged these segregate genera into 9 major genera. Hooker (1886) further reduced the number of genera to three and described the various *Piper* species under 4 sections. Contemporary taxonomists discontinued even, the practice of subdividing the genus into sections and dealt the species directly under the genus. From taxonomic point of view, Piperaceae has been considered as a most difficult family. According to Howard (1973), the family is one of the worst messes in plant taxonomy. Because of all these problems and also due to the poor quality of the herbarium specimens of pioneering workers, Sir Joseph Hooker (1886) advised the local botanists in

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various 'centres of distribution' of species in Indo-Malayan region to "examine the plants on the spot, with a view to matching the sexes, and flowering with fruiting specimens, and to observing the transition from young to old foliage, and the effects of locality and climate on the character of each species". In India, two major, independent centres of distribution of species are recognized. They are: 1) the region of Sub-Himalayan and North-eastern hill ranges and 2) Southern Deccan. More than 108 species are recorded from India (Rahiman & Nair 1983). In the present investigation, systematics of all the species occurring in the Karnataka region of Deccan were taken up. However, the study does not include *P. betle* Linn. (betel vine) which has not been recorded in the wild state in India and cultivars of *P. nigrum* Linn. (common black pepper vine). The observations are based on a survey of the *Piper* species in Karnataka by the authors (Rahiman *et al.* 1979, 1981) in which more than 300 herbarium specimens were specially collected for the study.

KEY TO THE SPECIES

1. Spike pendulous, berry large or medium-sized, bracts adnate or decurrent at lower half, not pedicelled:
    2. Bracts adnate to the rachis at the medial position, margin narrow but free, berry does not attain red colour:
        3. Female spikes long, developing berry oblong .... *attenuatum*
        3. Female spikes short, developing berry ovate:
            4. Leaves, peduncle and young branches hirtellous .... *hookeri*
            4. Leaves, peduncle and branches glabrous, rarely minutely puberulous .... *argyrophyllum*
    2. Bracts decurrent at lower half, berry large, becomes reddish .... *nigrum*
    2. Bracts transformed into a fleshy cup:
        5. Outer surface of the cup puberous .... *trichostachyon*
        5. Outer surface of the cup glabrous .... *galeatum*
1. Spike erect, berry small, bracts peltate with a short pedicel:
    6. Fruiting spike sub-globose, leaf base acute .... *mullesua*
    6. Fruiting spike cylindric, leaf base symmetrically or asymmetrically cordate .... *longum*

P. attenuatum Ham. *ex* Miq., Syst. Pip. 306. 1843 & in Fl. Ind. Bat. 1(2): 451. 1859; J. Hooker, Fl. Brit. India 5: 92. 1886; Gamble, Fl. Madras 1205. 1925. *P. diffusum* Vahl. Enum. 1: 333. 1804. *P. Karok* Blume, Cat. Gew. Buitenz 33. 1823. *P. malamaris* Roxb., Fl. Ind. 1: 160. 1832. *P. Sirium* C. DC., in DC., Prodr. 16(1): 160. 1869. (Fig. 1).

A slender climber, dioecious. Leaves thin, pressed ones membranous-chartaceous, ovate, rarely cordate, 9.5-17.5 cm long and 4.0-8.5 cm broad, glabrous, sometimes minute white dots seen on the dorsal surface, ventral side green, dorsal, dark green, 2-3 pairs of prominent lateral ribs, all arising from the base or very near to it; stipule adnate, deciduous. Flowering spike narrow, filiform, ♂ upto 26.0 cm, ♀ upto 10.0 cm, fruiting spike upto 21.0 cm, peduncle glabrous. Bracts linearly-obovate to elliptic, sessile, adnate in the medial position with narrow but free margin. Stamens 3, rarely 4. Carpel single, astylocarpellous, ovary oblong, stigma mostly 4-lobed, lobes short, ovule solitary, errect. Berry, mature ones spherical, developing ones characteristically oblong, smaller than the commercial black pepper, 0.3-0.4 cm in diameter, bitter in taste.

Climbs over the supporting trees with the help of strong adventitious roots, not more than 5-9 m in height. The fruit is an indehiscent drupe but commonly treated as berry.

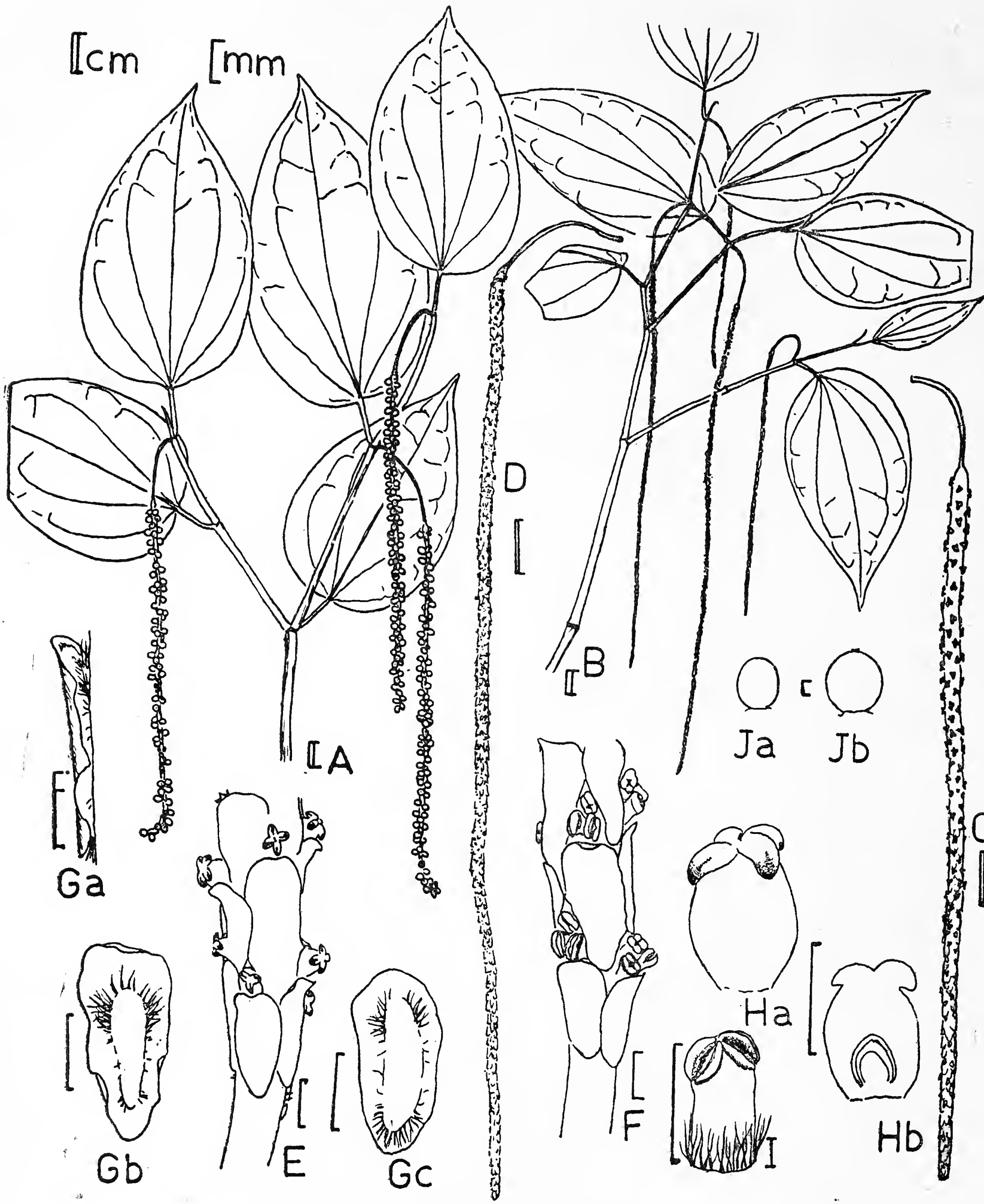

Fig. 1. *P. attenuatum* Ham.

A. Branch with fruiting spikes; B. Branch with male spikes; C. Female spike; D. Male spike; E. Portion of female spike; F. Portion of male spike; Ga. Female bract—side view; Gb. Female bract—bottom view; Gc. Male bract—bottom view; Ha. Ovary; Hb. Ovary—L.S.; I. Stamen; Ja. Young berry; Jb. Mature berry.

Young berry green in colour, mature ones black. Unlike *P. nigrum* Linn. the berries do not attain red colour during the development. Number of mature berries drop before fully mature. Runners are in plenty, cuttings of the runners start flowering in the very next season of planting. Flowers in May-July period. Off season flowerings common.

Saldanha and Nicolson (1976) considered *P. attenuatum* as synonym of *P. trioecum* Roxb. and Gamble (1925) considered the latter under *P. attenuatum.* Miquel (1843) and C. de Candolle (1869) considered them as two distinct species. *P. trioecum* was established by Roxburgh (1820). In his FLORA INDICA he described a male, a female and a bisexual vine. A close perusal of the descriptions of these 3 vines furnished by him clearly showed contrasting diagnostic characters — the bisexual vine showed 2 stamens and the berries which are pungent, ripened perfectly in the spike and the male one showed 3 stamens and the berries which are non-pungent, dropped before full maturity in the spike. (The former set of characters are similar to the characters observed in *P. nigrum* and the latter, are similar to that of *P. attenuatum*). From this it is obvious that these vines do not belong to one and the same species as William Roxburgh believed. The type specimen of *P. trioecum* is not available in any Indian Herbarium and the figure given by Wight (1853) in the ICONES PLANTARUM INDIAE ORIENTALIS, though said to be taken directly from Roxburgh's drawings, is not of much help to determine the identity. Hence the epithet *P. trioecum* is ignored in the present study.

Distribution: Bangladesh, Bhutan, Sri Lanka and Malaysia. In India, the Himalaya, Sikkim, Assam, Meghalaya and the Western Ghats. In Karnataka, very common in low level forests (lower than 200 m MSL) of Uttara Kannada and Dakshina Kannada districts.

Type locality. The Himalaya.

Selected specimens examined. Wallich 6642 D (CNH); Ansari 78563, Subramanian 77003 (BSI); Barber 5051; Henry 17394, 48263, Hooker & Thomson *exciccata sin. num.,* acc. no. 70410, Joseph 17190, 44488, Narayanaswami 3537, 5373, Raju & Naganathan 18146, 18156, 18206, Ramamoorthy 16153, Sebastine 15688, 16520, 25055, Subbarao 24528, 30052, 32877, 44384, 42575, Subramanyan 3846, 8066, Vajravelu 32131, Wight *sin. num.,* acc. no. 43777, 43778, 43779, 10881, 15723 (MH); Nicolson & Ramamoorthy 246, Saldanha 10068, 11412, 13899, 14232, 14415 (CTS)[4]; Rahiman 29, 33, 34, 37, 40, 49, 50, 65, 69, 70, 74, 115, 142, 143, 208, 229, 240, 254, 259, 262, 268 (MUK)[5].

P. hookeri Miq., London J. Bot. 4: 437. 1845; J. Hooker, Fl. Brit. India 5: 88. 1886; Gamble, Fl. Madras 1204. 1925. *P. hymenophyllum* Miq., London J. Bot. 4: 437. 1845. *P. lanatum* Wight *ex* Miq., London J. Bot. 5: 533. 1846. non Roxb. 1832. *P. nilighirianum* C. DC., in DC., Prodr. 16(1): 364. 1869. *P. Wightii* Miq., London J. Bot. 5: 552. 1846 (Fig. 2).

Allied to *P. attenuatum* Ham. *ex* Miq. and *P. argyrophyllum* Miq. Resembles *P. attenuatum* in majority of morphological characters. The major differences are the presence of crisp hairs on young branches, entire ventral surface and along the major ribs on dorsal surface of the leaves, petiole and bracts in this species. Leaves thinly coriaceous, upto 17.0 cm long and 7.0 cm broad, very much variable in size, shape and thickness. ♂ spikes upto 14.0 cm, fruiting spikes upto 20.0 cm, stamens 3 in number.

[4] CTS — Centre for Taxonomic Studies, Bangalore, Karnataka.

[5] MUK — Mangalore University, Mangalore (Konaje), Karnataka.

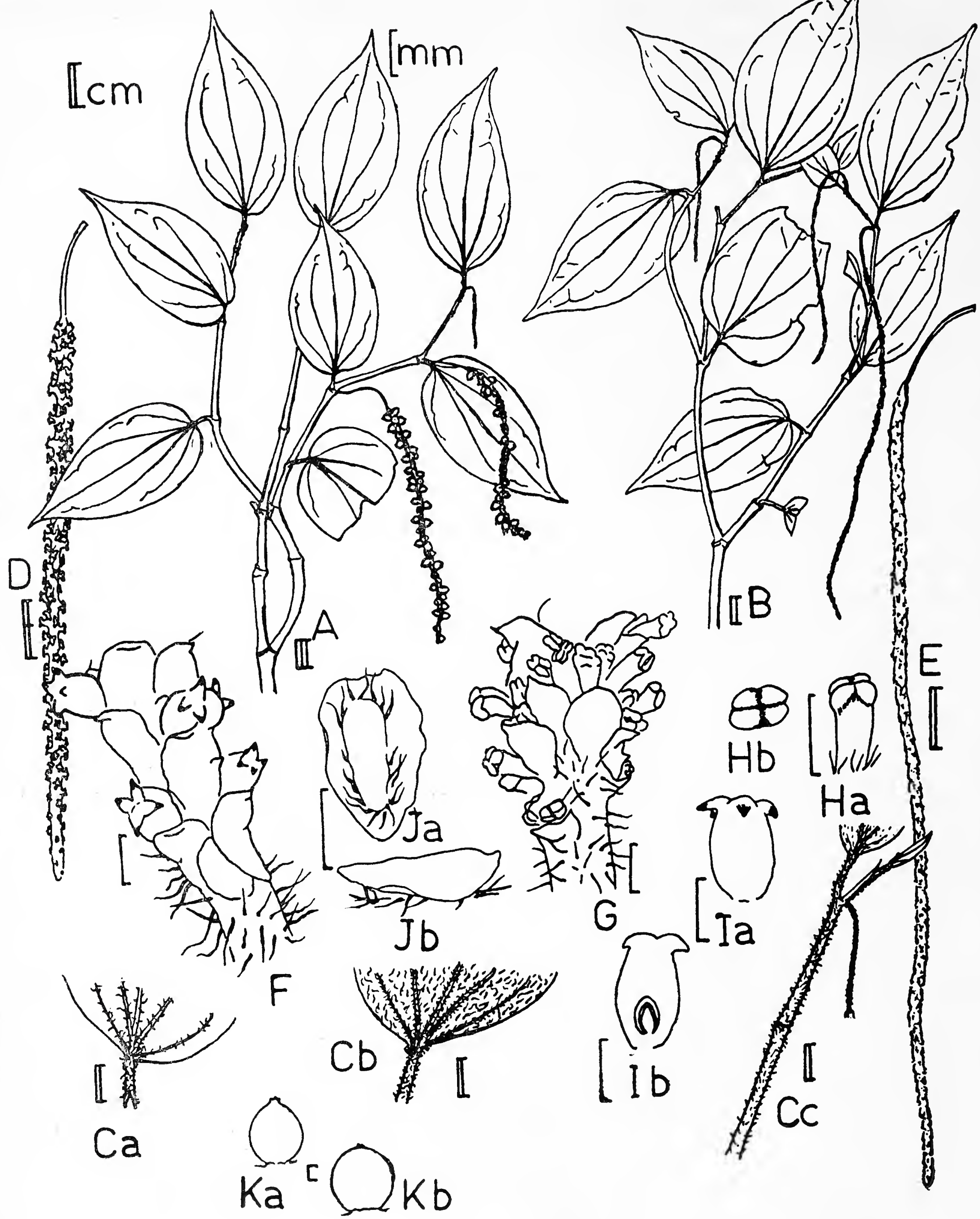

Fig. 2. *P. hookeri* Miq.

A. Branch with fruiting spikes; B. Branch with male spikes; Ca. Portion of leaf—dorsal side showing hairs; Cb. Portion of leaf—ventral side showing hairs; Cc. Tip of the branch showing hairs; D. Female spike; E. Male spike; F. Portion of female spike; G. Portion of male spike; Ha. Stamen; Hb. Anther lobes — top view; Ia. Ovary; Ib. Ovary — L.S.; Ja. Bract — bottom view; Jb. Bract — side view; Ka. Young berry; Kb. Mature berry.

Some problem pertaining to the identity of this taxa was encountered in the literature. Brandis (1906) and Cooke (1903) described a species with hairy vegetative and floral parts from the Western Ghats and considered it as *P. hookeri.* Saldanha and Nicolson (1976), on the other hand, considered a similar taxa from Karnataka as *P. hymenophyllum.* Hooker (1886) and Gamble (1925) described two such taxa from the Western Ghats and identified them as two distinct species, namely *P. hookeri* and *P. hymenophyllum.* Gamble (1925) reported the former from Bababudan hills (Bababudan hills are situated in the Karnataka region of the Western Ghats) and the latter from the Western Ghats of Mysore (Karnataka). We studied a number of specimens with hairy nature from all over Karnataka including Bababudan hills. The morphological characters showed wide variation but did not show any sharp discontinuities to merit differentiation into two species. *P. hookeri* and *P. hymenophyllum* were established by Miquel in 1845 and 1846 respectively. In the original diagnosis, the differences mentioned were the presence of adnate bract in *P. hookeri* and linear-oblong, adnate bract with undulated margin in *P. hymenophyllum* and the coriaceous to membranous leaves in the former and finely membranous and transparent leaves in the latter. In all other characters the two were identical. The leaf characters, as Miquel himself remarked were variable in these two species. In the light of variability noticed in the morphological characters in the genus, the differences mentioned in the original diagnosis are quite inadequate to differentiate these two into two different species. Therefore it would be realistic to consider these two species as conspecific. Since *P. hookeri* was validly published in 1845 and *P. hymenophyllum*, in 1846, the former is to be considered as the valid specific epithet. Therefore, in the present work, the hairy species is considered as *P. hookeri.*

Distribution: Reported only from the Western Ghats and Biligirirangan hills. In Karnataka occurs in Uttara Kannada, Shimoga, Hassan, Kodagu, Chikmagalur and Mysore districts, mostly in the forests situated at more than 200 m above sea level.

Type locality. Bombay.

Selected specimens examined: Arora 46275, 55232, Chibber *sin num.*, Janardhan 72150, Mahajan 24792, Pan 14462, Rao 79970, Rolla 87487, Raghavan 62477, 67853, 80838, 86982, 94119, Talbot 1602, 2459, Reddi 97261, 97826, *Exiccata sin. num.*, acc. no. 6962 (BSI); Barber 5450, 5489, 7555, 7539, 7559, 7560, 7563, 7595, 7346, Bourne 6112, 6085, Ellis 16957, Jacob 391, 427, 17666, Ramamoorthy 18188, 22882, Sebastine 17275, Viswanathan 691 (MH). Nicolson, Ramamoorthy & Gandhi 2884, Ramamoorthy & Gandhi 2608, Saldanha 9049, 9053, 10704, 13581, 16753 (CTS); Rahiman 12, 890, 893, 905, 910, 911, 957, 958, 984, 998, 1000, Fc 230, 231, 236, 248, 258 (MUK).

P. argyrophyllum Miq., Syst. Pip. 330. 1843; J. Hooker, Fl. Brit. India 5: 93. 1886; Gamble, Fl. Madras 1205. 1925. *P. walkeri* Miq., London J. Bot. 4: 438. 1845. *P. Wightii* Miq., London J. Bot. 5: 552 in part 1846. (Fig. 3).

Allied to *P. attenuatum.* It differs from *P. attenuatum* by the presence of silvery scales or blotches on the ventral surface of the leaves. Leaves chartaceous to thinly coriaceous, upto 21.0 cm long and 7.0 cm broad, sometimes sparsely distributed minute hairs are also seen on the ventral side. Stamens 3 in number. Rarely *P. argyrophyllum* may lack silvery blotches and *P. attenuatum* may show similar blotches in some leaves and as such it is very difficult to separate these two species, especially based on herbarium specimens. It

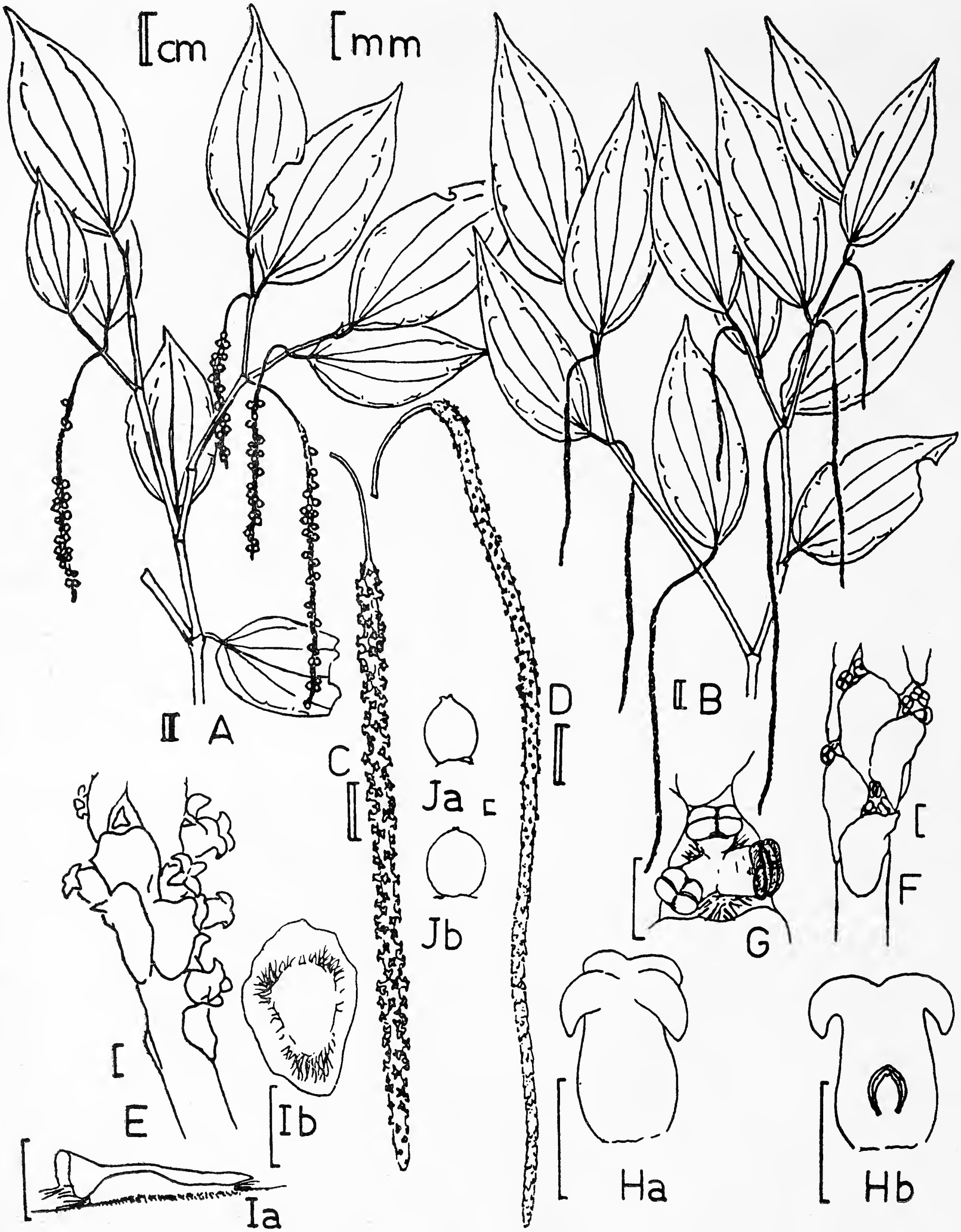

Fig. 3. *P. argyrophyllum* Miq.

A. Branch with fruiting spikes; B. Branch with male spikes; C. Female spike; D. Male spike; E. Portion of female spike; F. Portion of male spike; G. Portion of male spike showing stamens; Ha. Ovary; Hb. Ovary — L.S.; Ia. Bract — side view; Ib. Bract — bottom view; Ja. Young berry; Jb. Mature berry.

is also allied to *P. hookeri* and because of the presence of sparsely distributed hairs, poses difficulty in separating these two species as well.

Distribution: In India reported only from the Western and the Eastern Ghats. In Karnataka, occurs in Chikmagalur, Hassan, Shimoga, Kodagu, Uttar Kannada and Mysore districts. Occurs in higher altitude forests. Both *P. argyrophyllum* and *P. hookeri* are seen in the same locality.

Type locality. The Western Ghats.

Selected specimens examined. Fisher *sin. num.*, Singh 124569 (BSI); Barber 6498, 7202, 7313, 7344, 8710, 8712, 8713, 8715, Ellis 34891, Gamble 18392, Henry 16282, 16286, Joseph 12705, 12793, 13789, Karthikeyan 26834, Narayanaswamy 3875, Shetty 32327, Rao 31999, Vajravelu 33840, 35123, 41724 (MH); Nicolson & Ramamoorthy 2866 (CTS); Rahiman 165, 167, 172, 207, 212, 213, 228, 230, 240, 244, 253, 255, 257, 258, 263 (all the specimens fully glabrous), 209, 231, 232, 240, 242, 243, 264, 272 (all are puberulous in young vegetative parts) (MUK).

P. nigrum Linn., Sp. Pl. 28. 1753; Roxb., Fl. Ind. 1: 150. 1832; Gamble, Fl. Madras 1204. 1925; *Piper rotundum nigrum* Casparus, Fl. Mal. 54. 1696. *P. aromaticum* Lam., Illust. 1: 79. 1791. *P. baccatum* C. DC., in DC., Prod. 16(1): 242. 1869. *P. colonum* Presl, Bot. Bemerk. 112. 1844. *P. fallax* Vahl, Enum. 1: 335. 1804. *P. glyphicum* Hoffmag. *ex* Kunth, in Linnaea 13: 573. 1839. *P. malabarense* C.DC., in DC., Prodr. 16(1): 242. 1869. *P. spurium* Link, Enum. Hort. Berol. 1: 37. 1821. *Muldera multinervis* Miq., London J. Bot. 5: 557. 1846. *M. Wightiana* Miq., l.c. 558. 1846. (Fig. 4).

A vigorous vine, stem thick, rough in texture. Leaves thick, pressed ones coriaceous, broadly ovate to elliptic, 9.0-21.0 cm long and 2.5-13.0 cm broad, in males usually smaller and narrower, 2-3 pairs of prominent lateral ribs, the anteriormost pair emerges alternately about 2.0-3.5 cm above the leaf base, entirely glabrous, dorsal side green, ventral light coloured, stipules deciduous, adnate to the petiole. Spike narrow, filiform, pendulous, young ones green, mature ones yellowish, ♂ upto 16.0 cm and ♀ 12.5 cm, female spikes usually much smaller, peduncle glabrous. Bracts in the ♂ linearly oblong, decurrent, sessile, upper half with free margin, in ♀ same as in the male but the upper portion forms a thin hemispherical cup-like depression probably due to the presence of the spherical ovary, outer surface glabrous. Stamens consistently 2. Carpel single, ovary spherical, style represented by a mere constriction, stigma 3-5 lobed, lobes elongate, papillate. Berry spherical 0.5-0.6 cm in diameter, pungent.

Very common in the forest slopes of the Western Ghats, found climbing over the supporting trees both by twining and striking roots at the nodes, ascends to a height of 10 m or more. Flowers during May-June period, off season flowering rare. Fruit in ripening undergoes a colour change from green to red to black. More than 75 cultivars are known to be cultivated for their fruits, which are marketed as the famous 'black pepper'. The cultivars of black pepper are quite similar to the wild ones. The only major difference is the monoecious nature of cultivars and dioecious nature of the wild vines. However, hermaphrodite forms of wild vines and female forms of cultivars are also known.

Distribution: Indonesia, Malaysia, and Brazil. In India, occurs wild in the forests of the Western Ghats and the Eastern Ghats and cultivated in Kerala, Karnataka, Tamilnadu and Maharashtra. In Karnataka, both cultivated and wild forms occur in Dakshina Kannada, Uttara Kannada, Shimoga, Kodagu, Chikmagalur and Hassan districts.

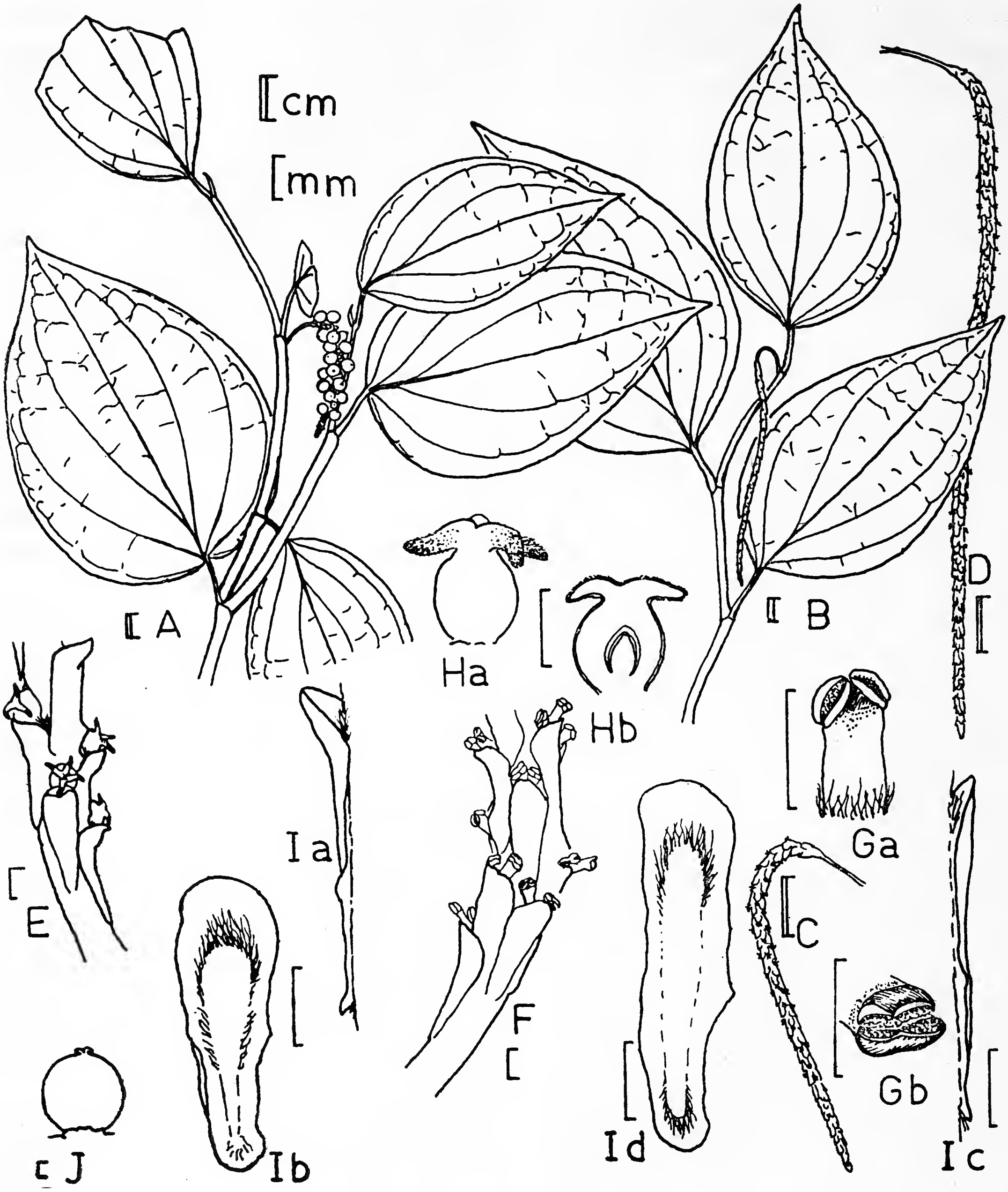

Fig. 4. *P. nigrum* Linn.

A. Branch with fruiting spike; B. Branch with male spike; C. Female spike; D. Male spike; E. Portion of female spike; F. Portion of male spike; Ga. Stamen; Gb. Anther lobes after anthesis; Ha. Ovary; Hb. Ovary — L.S.; Ia. Female bract — side view; Ib. Female bract — bottom view; Ic. Male bract — side view; Id. Male bract — bottom view; J. Mature berry.

Type locality. India.

Selected specimens examined. Kanodia 9626, Patil 2921, Puri 1114, Rolla 84917, Subramanian 70796, 71600, Wadwa 4313, 109793 (BSI); Barber 5466, 5945, 7410, 7414, 8708, 8709, Bourne 369, Naithani 24170 (MH); Saldanha 11474, 12599, 13274, 14634, 15071, Ramamoorthy & Gandhi 2655 (CTS); Rahiman 3, 4, 5, 6, 19, 22, 36, 38, 42, 43, 73, 75, 76, 85, 86, 95, 111, 112, 114, 116, 117, 122, 130, 132, 148, 200, 210, 211, 239 (MUK).

P. trichostachyon (Miq.) C.DC., in DC., Prod. 16(1): 242. 1869. J. Hooker, Fl. Brit. India 5: 80. 1886; Gamble, Fl. Madras 1206. 1925. *Muldera trichostachya* Miq., London. J. Bot. 5: 556. 1846. (Fig. 5).

A stout-stemmed climber. Leaves alternate, coriaceous, entirely glabrous, usually oblong but variable from ovate to lanceolate, upto 20.0 cm long and 10.0 cm broad, in males leaves smaller and narrower, 2-3 pairs of prominent lateral ribs, the anteriormost pair emerges from the midrib simultaneously about 2-3 cm above leaf base, nerves strong beneath, dorsal side green, ventral, light coloured, glaucous in appearance. Spike narrow, filiform, ♂ upto 9.5 cm, ♀ upto 7.0 cm, fruiting spike upto 10.0 cm, peduncle glabrous except for a strip of hairy tissue on the upper portion which might represent the decurrent part of the lowermost bract. Bract decurrent at the base, upper portion transformed into a fleshy obconical or hemispherical cup with a narrow slit like mouth, entire bract puberulous or hirtellous. Stamens consistently 2, short. Carpel single, ovary obovate, style absent, stigma 3-4 lobed, lobes short. Berry spherical or oblong, larger than commercial black pepper, 0.6-0.8 cm in diameter.

Climbs to a height of 10 m or more, stem may grow to a thickness of more than 6.0 cm, covered with thick cork which in old vines, is longitudinally furrowed. Occurs only in higher altitude forests (more than 700 m above sea level). Compared to all the other species, this one and *P. galeatum* (Miq.) C.DC., are hardy species and can withstand slightly dry climate. These two species are occasionally encountered along with cultivated Pepper in some plantations. Flowers in May-June period, off season flowerings observed. Fruits in ripening undergo a colour change from green to yellow to orange to red, slightly less pungent than commercial black pepper and are sometimes used as adulterant while marketing the latter.

Distribution: India and Malaya (Malaysia). In India reported only from the Western Ghats. In Karnataka, Shimoga, Chikmagalur, Coorg, southern part of Uttara Kannada and western part of Hassan districts.

Type locality. Malabar (Kerala).

Selected specimens examined. Cooke 46350 A, Arora 85576, Rao 79977 (BSI); Jacob 537, Narayanaswami 3538, 5407, Subramanyam 27703, Vivekanathan 45642, Wight *exciccata sin. num.*, acc. no 43008, 43009 (MH); Saldanha 12247, 15775, 15798, Nicolson, Saldanha & Ramamoorthy 37 (CTS); Rahiman 62, 105, 107, 121, 138, 144, 147, 155, 162, 163, 178, 187, 191, 196, 201, 202, 203, 210, 213, 233, 234, 235, 237, 246, 266 (MUK).

P. galeatum (Miq.) C.DC., in DC., Prodr. 16(1): 242. 1869; J. Hooker, Fl. Brit. India 5: 80. 1886; Gamble, Fl. Madras 1206. 1925. *P. Talbotii* C.DC., in Fedde, Repert. 10: 523. 1912 *nomen. Muldera galeata* Miq., London J. Bot. 5: 557. 1846. (Fig. 6).

Similar to *P. trichostachyon* in all the characters except for the absence of hairs on the outer surface of the bracts. Young spikes are pink in colour in some vines and green in others.

Several botanists including Miquel (1846), C. de Candolle (1869), Hooker (1886) and

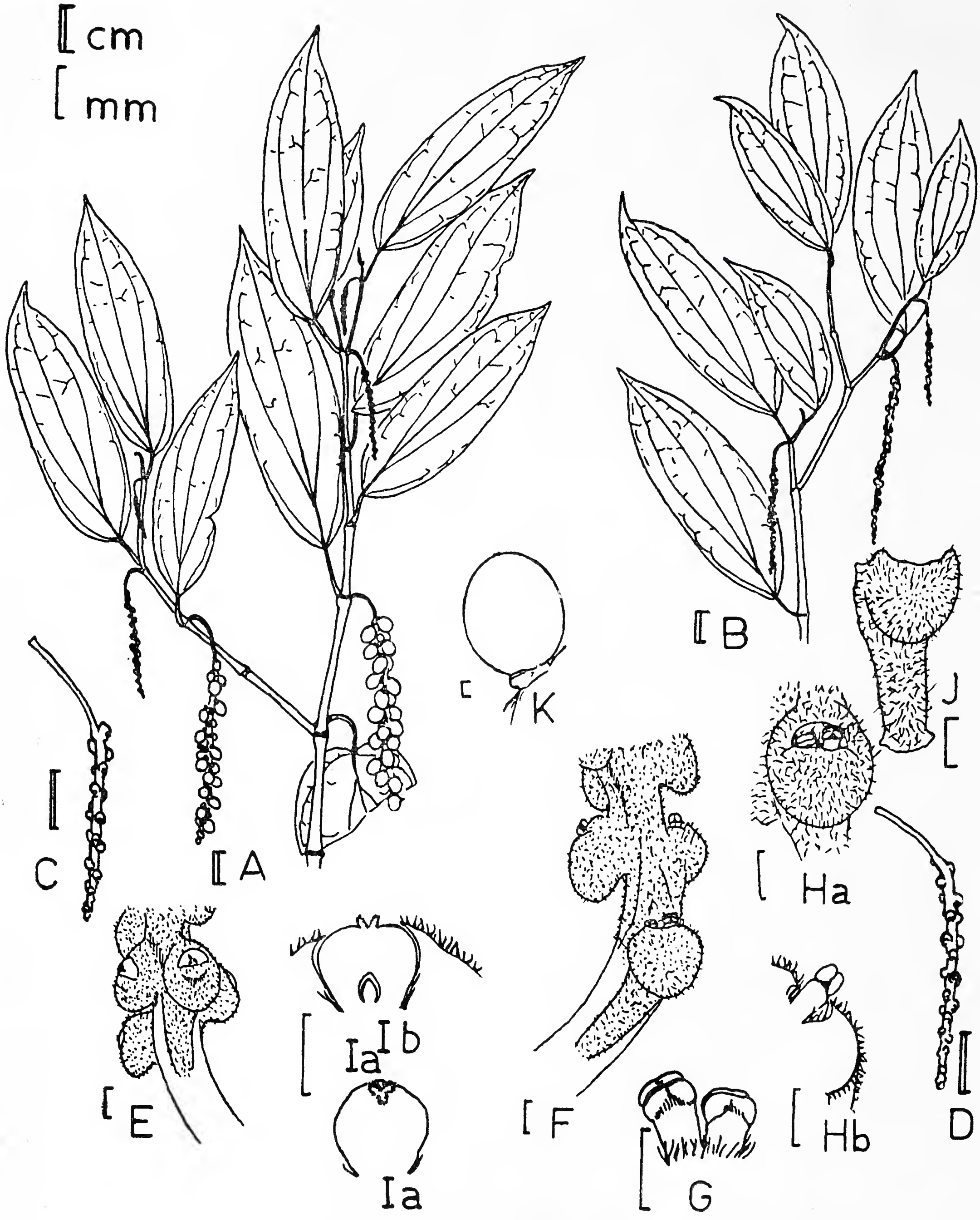

Fig. 5. *P. trichostachyon* C. DC.
A. Branch with fruiting spike; B. Branch with male spike; C. Female spike; D. Male spike; E. Portion of female spike; F. Portion of male spike; G. Stamens; Ha. Flower showing stamens; Hb. Flower with stamen — L.S.; Ia. Ovary; Ib. Ovary — L.S.; J. Bract; K. Mature berry.

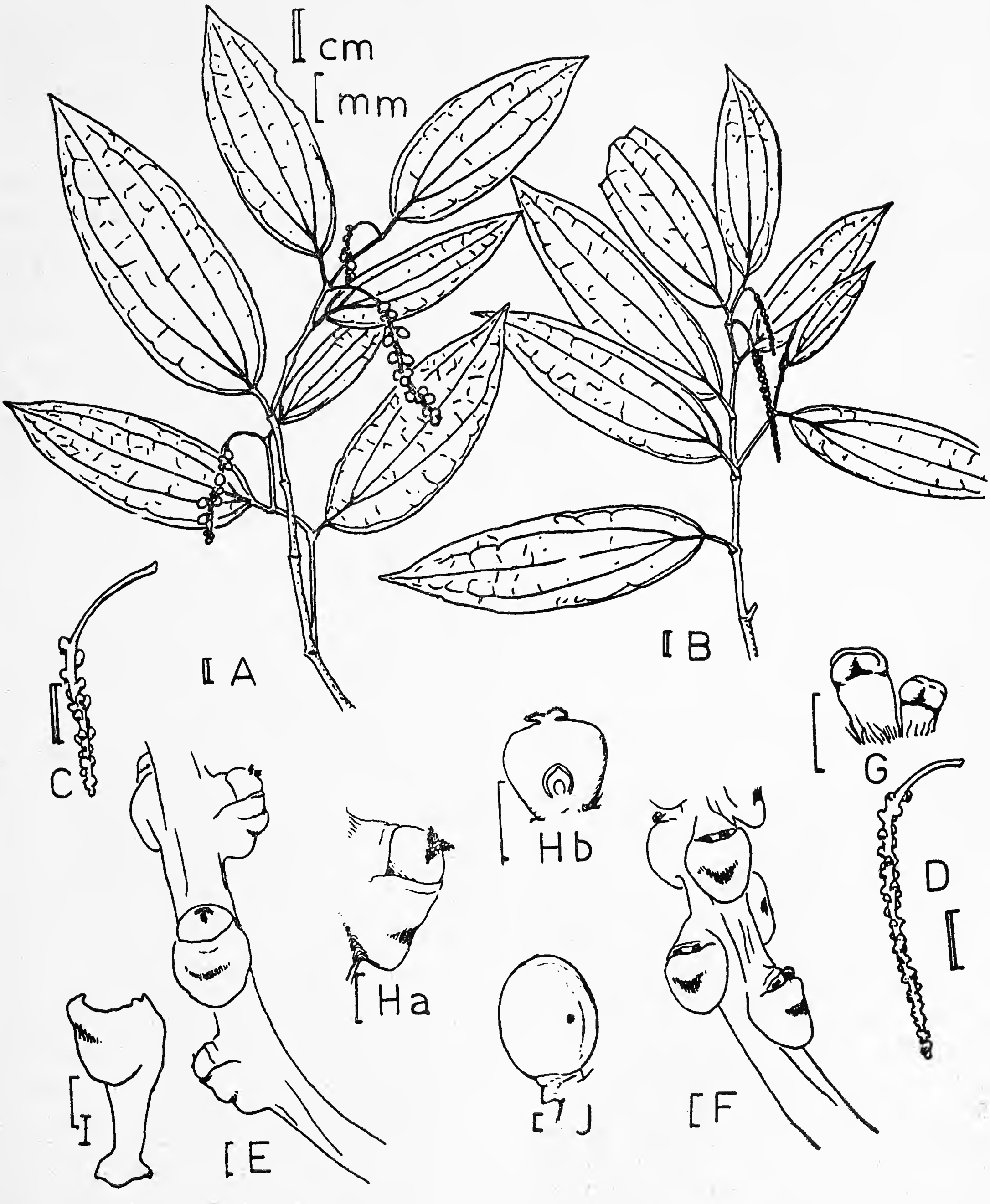

Fig. 6. *P. galeatum* C. DC.
A. Branch with fruiting spikes; B. Branch with male spikes; C. Female spike; D. Male spike; E. Portion of female spike; F. Portion of male spike; G. Stamens; Ha. Female flower; Hb. Ovary — L.S.; I. Bract; J. Mature berry.

Gamble (1925) distinguished *P. galeatum* from *P. trichostachyon* by distantly arranged flowers, presence of sessile bracts and absence of hairs on the outer surface of the bracts in contrast to the closely placed flowers, stipitate bracts and presence of hairs on bracts. Of these, the first two characters are of relative nature. While the typical *P. galeatum* from Cardamom hills shows stipitate and distantly placed flowers, the same species occurring in Anamalai hills shows almost sessile and comparatively closely placed flowers[6]. *P. galeatum* from Karnataka region also shows almost sessile and very closely placed flowers. The third character, namely the presence and absence of hairs, on the other hand, is an absolute character and hence could alone be taken as the diagnostic character to distinguish these two species.

Distribution: India and Java. In India, the Western Ghats from Bombay to Yellapur of Karnataka and from Anamalai hills to Travancore hills. In Karnataka, northern part of Uttara Kannada district.

Type locality. Peninsular India (Courtallum of Tamilnadu?)

Selected specimens examined. Talbot 1219 (CNH); Ahuja 31626, 47696, Cooke *exciccata sin. num.*, acc. no. 12333, 16689, Hemadri 104440, Janardhan 70108, 76614, 81777, Mahajan 17176, Puri 12605, Reddi 85946, 95813, 99326, Ryan 1757, Rolla 83427, Talbot 1593, 2888, Vasavada 9320 (BSI); Barber 5426, 5441, 5467, 5483, 5484, 5485, 5486, 7192, Ramamoorthy 16145, Wight *exciccata sin. num.*, acc. no 42973 (MH); Rahiman 53, 54, 55, 56, 57, 58, 59, 270, 273, 297 (MUK).

P. mullesua Ham., *ex* D.Don, Prod. Fl. Nep. 20. 1825; C.DC., in DC., Prod. 14(1): 338. 1869. *P. brachystachyum* Wall., in Wall. Cat. 6656 in part. 1832. *P. guigual* Ham. *ex* D. Don, Prod. Fl. Nep. 20. 1825. *P. vasculosum* Wall., Cat. 6660. 1832. *Chavica Guigual* Miq., Syst. Pip. 280. 1843. *C. Mullesua* Miq., l.c. 280. 1843. *C. spherostachya* Miq., l.c. 278. 1843. (Fig. 7).

Slender-branched extensive climber, stem rarely attains more than 1.5 cm thickness, branches entirely glabrous, runners many, characteristically puberulous. Leaves alternate, coriaceous, elliptic, upto 14.5 cm in length and upto 5.5 cm in breadth, usually much smaller in size, tip caudate-acuminate, bent, 2 pairs of prominent lateral ribs of which the anteriormost one emerges about one-thirds above the leaf base, the others emerge from the base, nerves strong beneath, dorsal side green, ventral dark green. Spike erect, cylindric in male, upto 4.5 cm in length, female very small, oblong, white, about 0.4 cm in length and 0.3 cm in breadth, fruiting spike upto 1.2 cm in length and 0.7 cm in breadth. Bracts orbicular, peltate, pedicelled. Stamens 2, filament short, thick, anther lobes single reniform, attached transversely at the tip of the filament, pollen sacs 2, dehisce by conspicuous longitudinal cleft at the crest and the wall of the sacs recurve and form an umbrella like structure. Carpel single, ovary ellipsoid, style represented by a constriction, stigma mostly 3-lobed, lobes minute. Berry very small, spherical-obovate, very pungent, gives a burning sensation when chewed. Flowers during April-May period, off season flowering common. This species occurs only in very high altitude forests (more than 700 m above MSL).

This species has been commonly treated as *P. brachystachyum* Wall. by many of botanists including Hooker (1886) and Gamble (1925). The specific epithet *'brachystachyum'* was given by Wallich in his CATALOGUE (1832). Later Hooker (1886) published *P. brachystachyum* with requisite diagnosis. However, long before these, i.e. in 1825 itself, Hamil-

[6] C. de Candolle (1912) unpublished document available at Botanical Survey of India, Southern Circle, Coimbatore.

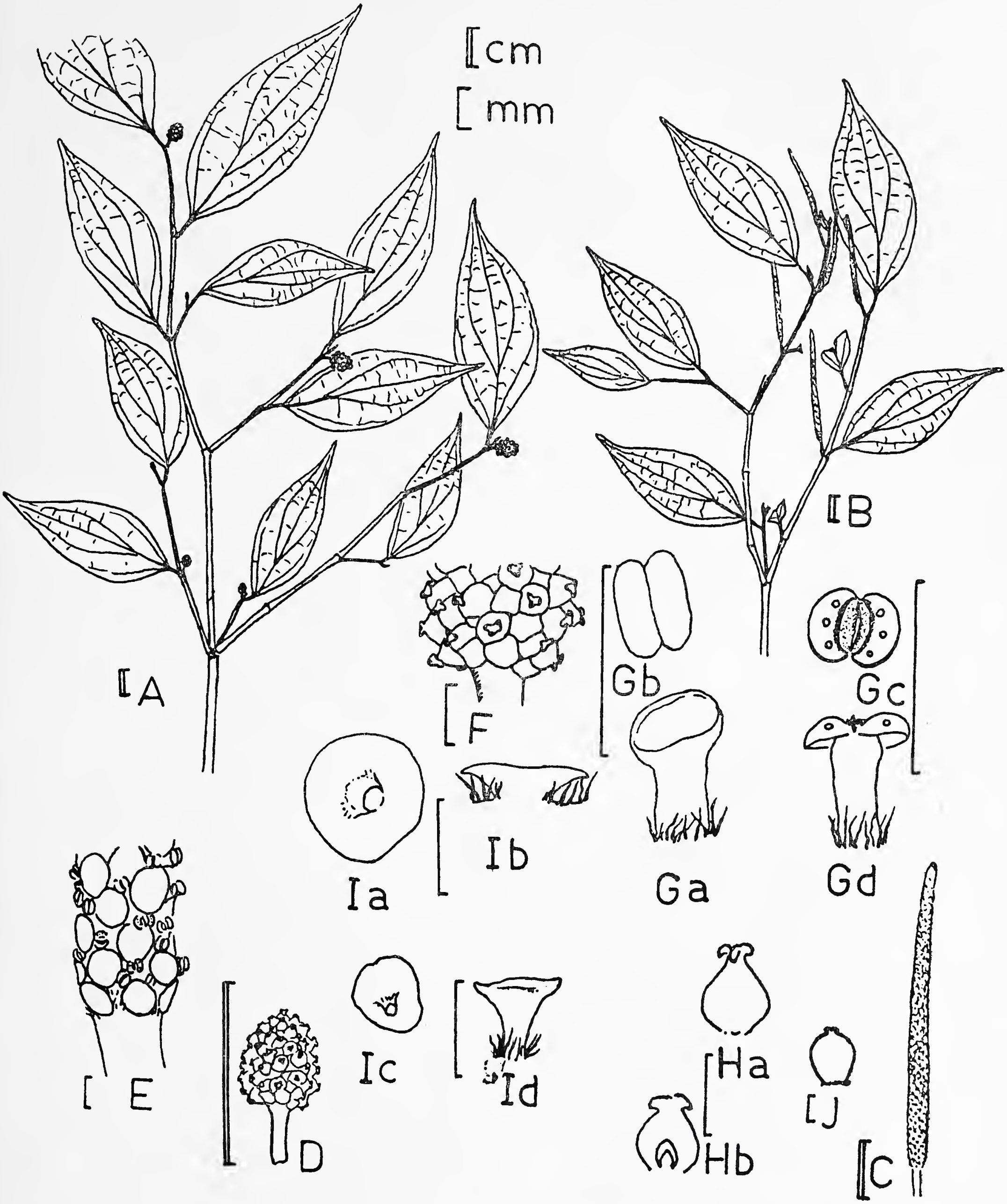

Fig. 7. *P. mullesua* Ham.

A. Branch with fruiting spikes; B. Branch with male spikes; C. Male spike; D. Female spike; E. Portion of male spike; F. Portion of female spike; Ga. Stamen; Gb. Anther lobes — top view; Gc. Anther lobes after anthesis — top view; Gd. Anther lobes after anthesis — side view; Ha. Ovary; Hb. Ovary — L.S.; Ia. Male bract — bottom view; Ib. Male bract — side view; Ic. Female bract — bottom view; Id. Female bract — side view; J. Berry.

ton validly published this species as *P. mullesua* in Don's PRODROMUS FLORAE NEPALENSIS. Raizada (1966) corrected this by considering *P. mullesua* as the valid name.

Distribution: India, Nepal, Bhutan and Eastern Islands. In India, the Himalayas from Simla to Bhutan, Khashi Hills and the Western Ghats. In Karnataka, Chikmagalur, Kodagu and Shimoga districts.

Type locality. Nepal.

Selected specimens examined. Wallich 6656 (CNH); Gamble 20631, Subramanian 71165, Talbot 3193 (BSI); Balakrishnan 129, Barber 1213, 5436, 5437, 5438, 5447, 5447 a, 5447 b, 5448, 5472, 6546, 6547, 7206, 7207, 7208, 7220, 7314, 7578, Beddome *exciccata sin. num.*, acc. no. 43091, Bharghavan 47443, Bourne 2374, Deb 31543, Ellis 34727, Gamble 20630, Henry 16421, Hooker *exciccata sin. num.*, acc. no. 70403, 70405, Jacob 16069, 17562, Lawson *exciccata sin. num.*, acc. no. 43078, 43088, Narayanswami 3801, 4440, Ramakrishnan 39108, Ramamurthy 18129, Rao 40472, 40489, Sebastine 2561, 3212, 4466, 18444, 24994, Sharma 35873, Vajravelu 29196, 35110, 36833, 38213, 38239, 43171, Viswanadhan 807, 975, Vivekanathan 40614, 40645, Wight *exciccata sin. num.*, acc. no. 43081, 43082 (MH); Rahiman 11, 15, 16, 96, 97, 101, 103, 140, 172, 174, 175, 208, 224 (MUK).

P. longum Linn. Sp. Pl. 29. 1753; Roxb., Fl. Ind. 1: 154. 1832; Gamble, Fl. Madras 1203. 1925. *P. sarmentosum* Wall. Cat. 6641. 1832. *P. latifolium* Hunter, in As. Res. 9: 390. 1809. *P. tubinatum* Noronha, in Verh. Batav. Gen. 5: 25, 1790. *Chavica Roxburghii* Miq., Syst. Pip. 230. 1843. *C. sarmentosa* Miq., London J. Bot. 4: 433. 1845; 5: 531 non Syst. Pip. 1846. (Fig. 8).

A slender undershrub, vegetative branches prostrate, rarely climbing to a short height, flowering ones erect or subscandent, young branches puberulous, hair minute but densely distributed. Leaves on the vegetative branches upto 13.0 cm long and 7.0 cm broad, cordate, equilateral with large auricles, leaves on the fruiting branches cordate to oblong-lanceolate, with inequilateral lamina, base deeply cordate with unequal but deep auricle, 3-4 pairs of prominent lateral ribs, all arise from leaf base, ventral side pale green, downy or puberulous, dorsal, light green, glabrous, petiole downy. Spike cylindric, erect, ♂ upto 10.0 cm long and 0.4 cm broad, ♀ upto 3.5 cm long and 1.0 cm broad, peduncle downy. Bracts peltate, pedicelled, orbicular, glabrous. Stamens 3-4. Carpel single, ovary obovate, style represented by a mere constriction, stigma 3-4 lobed, lobes short. Berry small, obovate, very pungent, about 0.2 cm in diameter.

Distribution: India, Sri Lanka and Malayan Islands. In India, east Nepal to Assam, West Bengal, and west coast of India. In Karnataka, collected only from Dakshina Kannada and Shimoga districts. Being an undershrub which dries and dies in the summer, it is difficult to locate. Among all the species in Karnataka, this is the only species which is found outside the perview of the forests and woodlands.

Type locality. India?

Selected specimens examined. Ryan *sin. num.*, Subramanian 70562, 77096, 77144, Talbot *exciccata sin. num.*, acc. no. 7905, 7906 (BSI). Barber 6078, 6656, 7161, 8728, Beddome *exciccata sin. num.*, acc. no. 43091, Bourdillon 449, Deb 30431, 30770, Ellis and Ramamurthy 18796, Henry 85, 16421, Joseph 17825, Narayanswami 3489, Ramamurthy 18129, 47644, Sebastine 717, 20810, 25369, 4466, 18444, Sharma 42451, Shetty 27381, Subramanyan 3489, Vajravelu 26277, 33372, 48844, 47443, Wight 886 (MH); Rahiman 1, 77, 78, 215, 222, 267 (MUK).

Several taxonomists described intraspecific categories such as varieties and forms in a

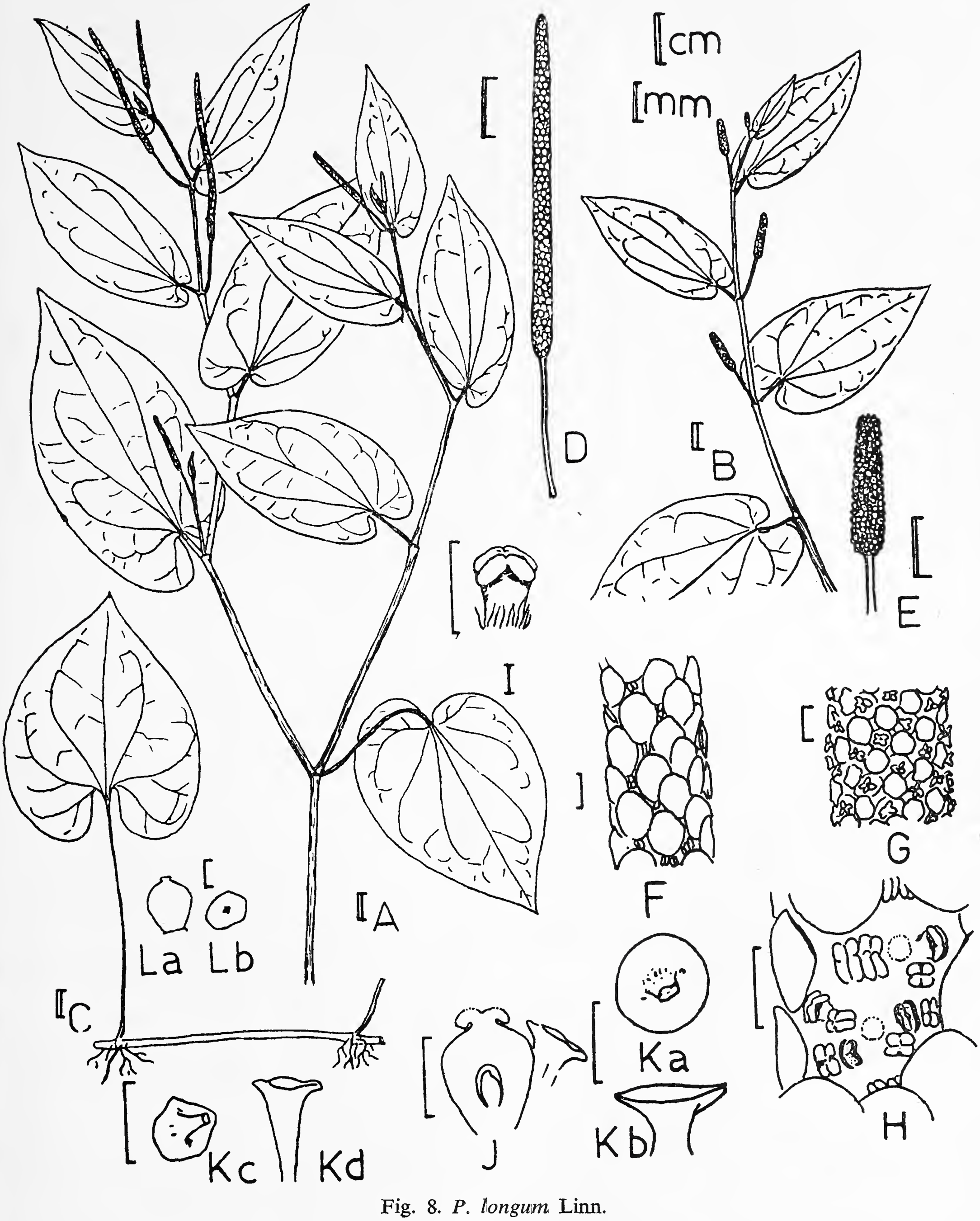

Fig. 8. *P. longum* Linn.

A. Branch with male spikes; B. Branch with female spikes; C. Runner with a leaf; D. Male spike; E. Female spike; F. Portion of male spike; G. Portion of female spike; H. Portion of male spike showing stamens (two of the bract removed); I. Stamen; J. Ovary — L.S.; Ka. Male bract — bottom view; Kb. Male bract — side view; Kc. Female bract — bottom view; Kd. Female bract — side view; La. Berry — side view; Lb. Berry — top view.

number of species of *Piper*. Among the Karnataka species, only a few such as *P. argyrophyllum, P. hookeri, P. nigrum* and *P. mullesua* were found to include subspecific categories. Hooker (1886) described six varieties under *P. argyrophyllum* but gave them just numbers (1 to 6). Brandis (1906) included a variety α under *P. brachystachyum* (*P. mullesua*) and a variety β under *P. hookeri*. C. de Candolle (1912) established a variety *mysorensis* under *P. nigrum*. All these varieties are mainly based on some minor variations in the length and breadth of leaves or size variations of spikes and flower parts. Because of the presence of extreme variability in the morphological characters in the genus and due to the absence of sharp taxonomic discontinuities in the characters within the species, it is not advisable to consider subspecific categories, unlelss the taxon under study is sufficiently different from the species which it has to be separated from. In the present study, none of the species was found to have sufficient variations to merit subdivision into a distinct variety.

Acknowledgements

We wish to express our sincere thanks to Dr (Fr) C. J. Saldanha, Director, Centre for Taxonomic Studies, Bangalore, for his kind help in the study. This paper is a part of the Ph.D. thesis (University of Mysore) of the senior author and he gratefully thanks the Council of Scientific and Industrial Research, New Delhi, for financial assistance.

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POLYCHAETA OF THE PULICAT LAKE (TAMIL NADU)[1]

S. K. SUNDER RAJ AND P. J. SANJEEVA RAJ[2]

(*With four plates*)

Polychaete fauna of the Pulicat Lake (Tamil Nadu) consisting of 25 species belonging 23 genera and 13 families, 20 of which are new records to this lake and two new to the brackishwaters of India are described, together with their distribution in the lake, and the taxonomic keys for all of them.

INTRODUCTION

Polychaetes constitute a major component of the bottom fauna of a lagoon like the Pulicat Lake as Raman *et al.* (1975) have shown, and they contribute an important link in the food-webs of a brackishwater ecosystem.

Among the major brackishwater bodies of India, the polychaete fauna of the Gangetic Delta and of the Chilka Lake have been thoroughly investigated, but no systematic work on the polychaetes of the Pulicat Lake, which is the second largest brackishwater body in India has been attempted.

The present survey was conducted during the years 1973-1978. As the Pulicat Lake is a major brackishwater fishing centre in Tamil Nadu, a knowledge of the polychaete fauna of this lake would be helpful from both the academic as well as from the fisheries points of view.

Topography of the Pulicat Lake. Russel (1898), Hornell (1910), Chacko *et al.* (1953), Krishnamurthy & Rao (1970), Joel (1973), Raman *et al.* (1975), Paul Raj (1976) and Jhingran (1977) have earlier described the topography of the Pulicat Lake.

Pulicat Lake (Lat. 13°24′ to 13°47′N and Long. 80°2′ to 80°16′E) covers an average area of about 461 sq. kilometres. The average depth of the lake is about 1.5 metres and the maximum depth is about 7.0 metres. The lake, at its southern end, close to Pulicat Town, opens into the Bay of Bengal by a narrow mouth (pass). In addition to this, there is also another seasonal pass near Duggirajapatnam (northernmost point). In the northern part of the lake, there are two large islands, Venadu and Irakkam (Plate 1) and a much smaller one called Kuruvithittu. On the eastern side, the Sriharikota Island extends north to south all along, as a narrow strip of land between the lake and the Bay of Bengal. After the establishment of the S.H.A.R. on the Sriharikota Island it is connected with Sulurpet Town on the mainland by a cement road. The Buckingham Canal runs parallel to the entire length of the lake and it opens into the lake here and there.

Hydrology and substrata of the Lake. Hornell (1910), Chacko *et al.* (1953), Michael (1970), Joel (1973), Srinivasan & Pillay (1972), Krishnamurthy (1973), Raman *et al.* (1975) and Paul Raj (1976) have described the hydrology of the Pulicat Lake.

The interesting feature of the lake is that during the flood season in November-December, the salinity is extremely low, but during the summer and post-summer months (April to September) it is hypersaline. Hornell (1910) observed fine sandy bottom along the shores

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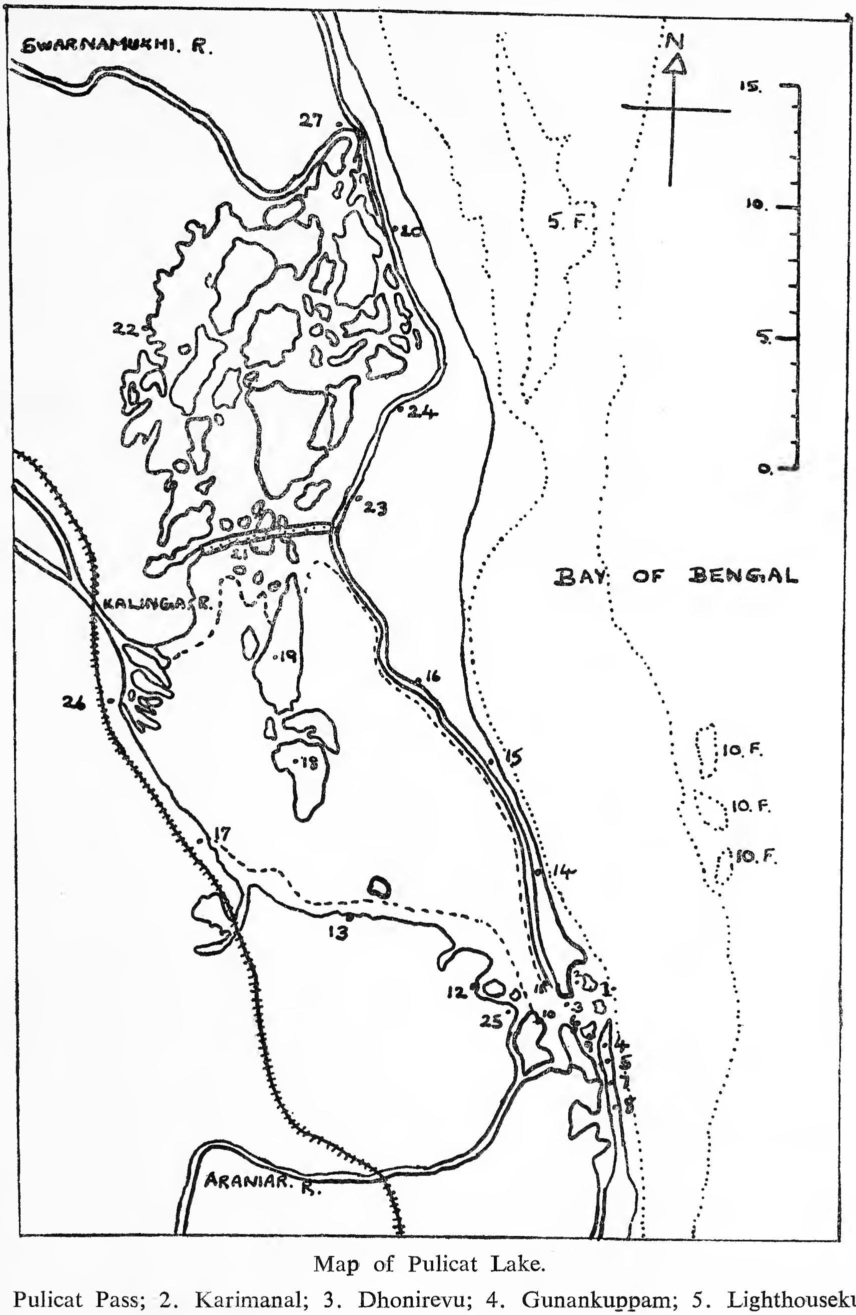
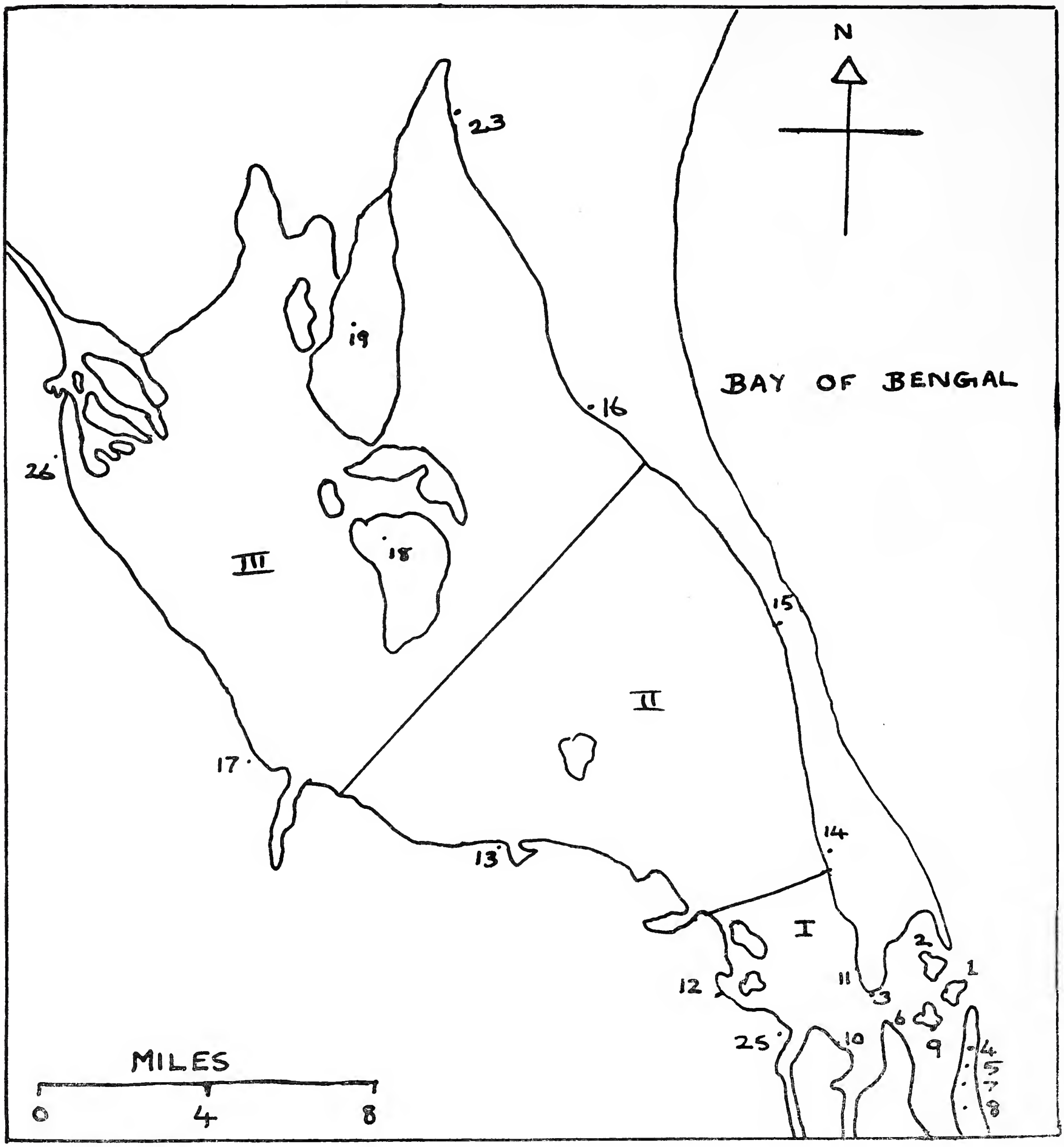


Map of Pulicat Lake.

1. Pulicat Pass; 2. Karimanal; 3. Dhonirevu; 4. Gunankuppam; 5. Lighthousekuppam; 6. Kottaikuppam lock; 7. Koraikuppam; 8. Sattankuppam; 9. Edamani; 10. Kulathumedu; 11. Moosamani lock; 12. Annamalaicheri; 13. Chunnambukulam; 14. Arangam; 15. Pulincheri; 16. Zonangipalam; 17. Arambakkam; 18. Irrakkam; 19. Venadu; 20. Berupet; 21. Atakanitippa; 22. Malan; 23. Sriharikotta; 24. Royduruah; 25. Avarivakkam; 26. Tada; 27. Duggirajapatnam.



Map of Pulicat Lake Showing zones.

Zone I: Sand with little admixture of mud.
Zone II: Sand and mud with equal proportions with patches of weeds.
Zone III: Mud.

1. Pulicat Pass; 2. Karimanal; 3. Dhonirevu; 4. Gunankuppam; 5. Lighthouse-kuppam; 6. Kottaikuppam lock; 7. Koraikuppam; 8. Sattankuppam; 9. Edamani; 10. Kulathumedu; 11. Moosamani lock; 12. Annamalaicheri; 13. Chunnambukulam; 14. Arangam; 15. Pulincheri; 16. Zonangipalam; 17. Arambakkam; 18. Irrakkam; 19. Venadu; 23. Sriharikotta; 25. Avarivakkam; 26. Tada.

of the lake near the lake-mouth (pass). Krishnamurthy (1971) observed three zones, based on the nature of the substratum, one zone characterised by the predominance of sand in the substratum, with little admixture of mud, a second zone having sand and mud in equal proportions with patches of weeds, and a third zone consisting entirely of mud. Of these three zones, the first and the second zones are rich in flora and fauna, and polychaetes particularly are plenty in the second zone (Plate 2).

Review of previous work on Polychaeta of India. The earliest work on the Polychaeta of the Indian region is that of Willey (1905), describing collections from the Gulf of Mannar. Later, Potts (1909) studied the Polychaeta of the Indian Ocean. Southern (1921) and Gravely (1927) described the Polychaeta occurring in the Krusadai Island, Chilka lake, Gangetic delta and Cochin backwaters. Bindra (1927) studied the polychaetes belonging to the genus *Eurythoe* from Karachi. Aziz (1938) studied the polychaetes of Karachi. Brackishwater polychaetes of Madras were studied by Panikkar & Aiyar (1937). This was followed by the contributions of Fauvel (1930, 1930a, 1932 and 1940), which culminated in 1953 in the publication of his comprehensive account of the Polychaeta of India in the FAUNA OF BRITISH INDIA series. He described 283 species from the coasts of India, which includes 47 brackishwater species and 236 marine forms. Day (1962) reviewed the list of the Polychaeta in the Western Indian Ocean. Polychaeta from the south-east coast of India were studied by Ghosh (1963). Some polychaetous annelids from the Andaman waters were studied by Tampi & Rangarajan (1964). Polychaetes from the Cochin harbour area were studied by Cheriyan (1966). Polychaeta from Maharashtra and Goa were studied by Parulekar (1971). More recently, the polychaetes of the Indian Ocean were catalogued by Hartman (1974).

Concerning the brackishwater polychaetes particularly of India, Southern (1921) in his classical work on the Fauna of the Chilka Lake described about 20 species of brackishwater polychaetes. Brackishwater polychaetes of the Gangetic Delta and Cochin Backwaters were also described by Southern (1921). Sewell (1934) described the brackishwater polychaetes of the salt lakes of Calcutta (Hugli river). Panikkar & Aiyar (1937) described the brackishwater polychaetes of the Adyar and Coovum estuaries near Madras. Alikunhi (1941, 1942, 1943, 1946, 1947, 1948 and 1951) studied the interstitial polychaetes of Madras.

Chacko *et al.* (1953) merely listed five species of Polychaeta from the Pulicat Lake, namely *Lycastis indica* Southern, *Nereis chilkaensis* Southern, *Marphysa gravelyi* Southern, *Lumbriconereis polydesma* Southern and *Polydora kempi* Southern. Krishnamurthy (1963) described six brackishwater polychaetes from the Adyar estuary, Madras. Balasubramanyam (1964), while describing the fauna of the Vellar estuary (Porto Novo) listed 28 species of polychaetes. Radhakrishna & Ganapati (1967) worked out the fauna of the Godavari estuary describing about 19 polychaete species.

In addition to the above faunistic surveys, some work has been done on the other aspects like anatomy, behaviour, reproductive biology, ecophysiology and biochemistry of some selected polychaetes. Ranganathan (1942) worked out the anatomy of *Glycera embranchiata.* Tampi (1946) worked out the structure of the eyes and tube-building organs of some selected polychaetes. Krishnan (1952) studied the nephridia of Nereidae and also the development of *Diopatra variabilis.* Anatomy and development of *Dasychone cingulata* was studied by Thomas (1955). Physiological studies on *Marphysa gravelyi* were conducted by Krishnamurthy (1962, 1963 and 1968).

Salinity tolerance and weight regulation in *Lycastis indica* were studied by Mary (1965). Table 1 compares the occurrence of the brackishwater polychaetes of India and their distribution.

Taxonomic methods. Southern (1921) has given more emphasis to parapodial structures rather than to the appendages of the anterior end. Fauvel (1953) has given more emphasis to the head morphology (prostomium, eyes, tentacles, tentacular cirri, gills, proboscis with its jaws and denticles). The keys given herein to identify the families of the polychaetes of the Pulicat Lake are based mainly on the head structures, whereas the keys for generic and specific levels are based on head structures as well as on parapodial characters.

Laboratory maintenance of polychaetes. A number of attempts were made to maintain polychaetes alive in the laboratory at the Madras Christian College, Tambaram, about 80 km inland from the Pulicat Lake. Most often the worms survived only for a week or so. The following method was successfully evolved subsequently to keep the worms alive for more than six months, away from their natural habitat.

Polychaete worms collected from the Pulicat Lake were transported by rail and road in about 4 hours and were brought to Tambaram in glass bottles containing the lake water. A perforated lid was used to allow ventilation. The lower halves of the glass bottles were filled with the bottom mud from the lake and the rest was filled with the lake water. The worms were seen to be readily burrowing into the mud at the bottom. After arriving at the inland lab, the worms, along with the lake water and mud, were transferred to glass troughs of five-litre capacity. Two litres of the lake mud at the bottom and two litres of the lake water were used in each glass trough. Dark slushy mud was noticed to decompose fast, hence shore sand was found to be ideal. The water in the glass troughs was constantly aerated, to avoid oxygen depletion. Salinity of the water was maintained around 35.01‰ by adding distilled water and sea water as may be required. The optimum salinity was noted to be 30 ± 5‰. The dissolved oxygen content in the water was on the average 3.684 ppm. Temperature of the water was on an average 26°C. The worms were able to live well in varying temperatures, the optimum temperature being 26 ± 5°C. In each such glass trough, about 25 worms were stocked. Species maintained at the inland lab were *Marphysa gravelyi, Nereis chilkaensis, Heteromastus similis* and *Euclymene annandalei.* If the number in each trough was raised above 25, mortality was noticed and this may be due to overcrowding in a small container. Stocking density may be 10-12 worms per litre.

Since most of the worms are detritus feeders, no supplemental food was supplied. They were presumed to be feeding on the detritus and on the plankton available in the water. These worms under such laboratory conditions survived for more than six months, so that they could be used for the present work.

Materials and Methods

Polychaetes were collected from nearly 27 stations representing all possible biotopes of the lake. Fishermen of the Pulicat Lake also collect polychaetes as bait for angling. Two methods are in vogue.

(i) *Intertidal collection.* The body fluids of crabs like *Portunus* sp., *Uca* sp., by breaking their appendages are spilt over the sandy shore. This odour of the crab seems to attract the worms to come out of their burrows. They are then gently caught by their heads and pulled out of their burrows.

(ii) *Bottom collection.* The villagers use a

TABLE 1

DISTRIBUTION OF POLYCHAETES IN BRACKISHWATER BODIES IN INDIA

	Brackishwater polychaetes of India	Pulicat Lake	Salt Lakes of Calcutta	Chilka Lake	Godavary Estuary	Madras Brackishwaters	Vellar Estuary	Vembanad Lake
1.	*Harmothoe ampullifera*	+	–	–	+	–	–	+
2.	*Leonira japonica*	–	–	–	–	–	+	–
3.	*Pisionidens indica*	+	–	–	–	–	+	–
4.	*Pisione complexa*	+	–	–	–	–	–	–
5.	*Hesione pantherina*	–	–	–	+	–	–	+
6.	*Hesione intertexta*	+	–	–	–	–	+	–
7.	*Eteone barantollae*	+	+	–	–	–	–	–
8.	*Ancistrosyllis constricta*	–	–	+	–	+	+	–
9.	*Tomopteris elegans*	–	–	–	–	–	+	–
10.	*Lycastis indica*	+	+	+	–	+	+	+
11.	*Tylonereis fauveli*	+	–	+	–	–	+	–
12.	*T. bogoyawlenskyii*	–	–	–	–	–	–	+
13.	*Nereis chilkaensis*	+	–	+	–	+	+	+
14.	*N. glandicincta*	–	+	+	–	+	+	+
15.	*N. reducta*	–	–	+	–	–	–	–
16.	*N. cavifrons*	±	+	–	–	–	–	–
17.	*N. cricognatha*	–	+	–	–	–	–	–
18.	*N. chingrighattensis*	–	+	–	–	–	–	–
19.	*Perinereis cavifrons*	–	–	–	–	–	–	+
20.	*P. marjorii*	–	–	+	–	–	–	–
21.	*P. cultrifera*	–	–	–	–	–	–	+
22.	*Dendronereis aestuarina*	–	+	+	+	–	–	+
23.	*D. arborifera*	–	–	–	+	–	–	–
24.	*D. heteropoda*	–	+	+	–	–	–	+
25.	*Nephthys polybranchia*	–	–	+	–	+	–	–
26.	*N. oligobranchia*	–	+	+	–	–	+	–
27.	*Goniada emerita*	–	–	–	–	–	–	+
28.	*Glycera alba*	+	–	+	–	–	–	+
29.	*Glycinde oligodon*	–	–	+	–	–	–	–
30.	*Onuphis eremita*	–	–	–	–	–	+	–
31.	*Diopatra neapolitana*	+	–	+	+	+	+	+

TABLE 1 (CONTD.)

32.	*Marphysa gravelyi*	+	–	+	+	+	+	+
33.	*M. sanguinea*	–	–	–	–	–	–	+
34.	*M. stragulum*	–	–	–	–	–	–	+
35.	*Lumbriconereis polydesma*	+	–	+	–	+	+	–
36.	*L. simplex*	+	–	+	–	–	+	+
37.	*L. pseudobifilaris*	–	–	–	+	–	–	+
38.	*L. heteropoda*	–	–	–	+	–	–	+
39.	*Scoloplos marsupialis*	–	–	+	–	–	–	–
40.	*Scoloplos indica*	–	–	–	–	+	–	–
41.	*Nerine cirratulus*	+	–	–	–	–	+	–
42.	*Polydora ciliata*	+	–	–	–	+	–	–
43.	*P. hornelli*	–	–	+	–	–	–	–
44.	*P. kempi*	–	+	+	–	+	–	–
45.	*Spio bengalensis*	–	+	–	–	–	+	–
46.	*Prionospio krusadensis*	+	–	–	–	–	–	–
47.	*P. polybranchiata*	–	–	–	–	–	+	–
48.	*P. cirrifera*	–	–	–	+	+	–	–
49.	*Myriochele picta*	–	–	+	–	–	–	–
50.	*Cossura delta*	–	–	–	–	–	+	–
51.	*Capitella* sp.	–	–	–	–	+	–	–
52.	*Heteromastus similis*	+	–	+	–	+	+	–
53.	*Paraheteromastus tenuis*	–	–	–	–	–	+	–
54.	*Mastobranchus indicus*	–	+	+	–	–	+	–
55.	*Barantolla sculpta*	+	+	+	–	–	–	–
56.	*Branchiocapitella singularis*	+	–	–	–	–	–	–
57.	*Euclymene annandalei*	+	–	+	+	–	+	–
58.	*E. insecta*	+	–	–	–	–	–	–
59.	*Sternaspis costata*	–	–	+	–	–	–	–
60.	*Pectinaria crassa*	–	–	–	–	–	+	–
61.	*Amphicteis gunneri*	+	–	–	–	–	–	–
62.	*Loimia medusa*	–	–	–	+	–	–	–
63.	*Pista indica*	–	–	–	–	–	–	+
64.	*Sabellaria spinulosa*	–	+	–	–	–	–	–
65.	*S. pectinata*	–	+	–	–	–	–	–
66.	*Laonome indica*	+	–	+	–	–	+	–
67.	*Potamilla leptochaeta*	+	+	+	+	–	–	–
68.	*Fabricia spongicola*	–	–	+	–	–	–	–
69.	*Hydroides norvegica*	+	–	–	–	+	–	–
70.	*Ficopomatus macrodon*	–	–	+	–	–	–	+
71.	*Mercierella enigmatica*	–	–	–	–	–	+	–

special teak plank, like a cricket-bat, made just for collecting polychaetes. The plank is about 60 to 75 cm long and about 15 cm broad, and about 10 cm. in thickness. The top has a handle, but the bottom is pointed. After choosing the proper habitat of polychaetes, they insert this plank deep into the soft ooze almost up to the handle, incline it outwards and rotate it in a semi-circle, thus scooping out the bottom mud. Polychaetes dislodged from such mud are collected by handpicking.

Polychaetes associated with oyster-shells were collected by dislodging the shells with a chisel and hammer. Interstitial polychaetes were collected by "Corer" as designed by McIntyre (1968).

Key for Identification

(a) key to identify Errantia and Sedentaria

Body vermiform, undivided into two regions; all segments nearly alike; Free-living......ERRANTIA

Body divided into two distinct regions, thorax and abdomen; usually tubicolous ....SEDENTARIA

(b) key to identify families of Errantia

1. Elytra present on a limited number of segments only; the posterior segments carry cirri .... Aphroditidae
   Elytra absent 2
2. Proboscis armed with four teeth; prostomium fused with buccal segment; feet uniramous .... Pisionidae
   Proboscis unarmed 3
3. Tentacles four to five; dorsal and ventral cirri foliaceous; setae compound. ..... Phyllodocidae
   Dorsal cirri long and moniliform 4
4. Head with two pairs of eyes; two or three tentacles; palps present or absent. ...... Hesionidae
   Proboscis with paragnaths. 5
5. Proboscis armed with a single pair of toothed jaws; tentacles two; parapodia biramous .... Nereidae
   Proboscis armed with two pairs of jaws tentacles four or more; parapodia biramous or sesquiramous 6
6. Prostomium conical, ringed with four small tentacles; palps absent. .... Glyceridae
   Prostomium distinct and well developed with tentacles and palps; proboscis complex. .... Eunicidae

(c) key to identify families of Sedentaria

1. Body clearly divided into regions 2
   Body not clearly divided into regions; prostomium without tentacles; palps without suckers; dorsal and ventral cirri foliaceous; hooded hooked setae. .... Spionidae
2. Prostomium conical without appendages; proboscis unarmed; dorsal and ventral cirri absent. .... Capitellidae
   Prostomium not conical 3
3. Prostomium rimmed with a cephalic plate; anal funnel with cirri. No gills .... Maldanidae
   Prostomium trilobed or hidden 4
4. Prostomium trilobed, buccal tentacles long and retractile into the mouth; three to four pairs of subulate branchiae inserted on the anterior segments. .... Ampharaetidae
   Prostomium hidden; with or without operculum 5
5. With an operculum; a thoracic membrane; tube calcareous .... Serpulidae
   Without operculum; no thoracic membrane; tube membranous. .... Sabellidae

(d) key to identify genera and species

Family 1. Aphroditidae

Eyes four; prostomium bilobed; three tentacles; dorsal setae stouter than the ventral with bidentate tips; sessile; elytra fringed with small papillae; ventral lamellae conspicuous .... *Harmothoe ampullifera*

Family 2. Pisionidae

Presence of two non-serrated buccal spines between the two palps with genital papillae in the 35th segment. .... *Pisione complexa*

Absence of buccal spines and palps longer than dorsal cirri of the buccal parapodia. .... *Pisionidens indica*

Family 3. Phyllodocidae

Prostomium with two pairs of tentacles and two pairs of tentacular cirri; proboscis with soft rows of papillae. .... *Eteone barantollae*

FAMILY 4. HESIONIDAE

Prostomium with two tentacles; palps absent; proboscis unarmed; paired brown spots on each intersegmental line .... *Hesione intertexta*

FAMILY 5. NEREIDAE

1. Feet uniramous; eyes arranged in a line; dorsal setae absent. .... *Lycastis indica*
Feet biramous. 2
2. Paragnaths present; dorsal cirrus longer and larger than ventral cirrus; no dorsal homogomph falcigerous bristles in posterior feet. .... *Nereis chilkaensis*
Paragnaths absent; ventral setigerous lobe bilobed in few segments; jaws with 12 teeth. .... *Tylonereis fauveli*

FAMILY 6. EUNICIDAE

1. Tentacular cirri present; tentacles with cirratophores .... *Diopatra neapolitana*
Tentacular cirri absent 2
2. Gills present, pectinate; comb setae arranged in middle region of the body..... *Marphysa gravelyi*
Gills absent. 3
3. Gills and eyes absent; feet with wing capillary setae and hooks absent. .. *Lumbriconereis simplex*
Hooks present .... *Lumbriconereis polydesma*

FAMILY 7. GLYCERIDAE

Gills inserted on the dorsal edge of the foot; proboscis with four long jaws; Dorsal setae simple capillary and ventral setae compound and winged; posterior lobes unequal. .... *Glycera alba*

FAMILY 8. SPIONIDAE

Prostomium conical; bidentate; hooded hooks; gills in anterior segments; anal cup present .... *Nerine cirratulus*
Prostomium rounded; gills pinnate; hooded hooks with four teeth; median anal cirrus present .... *Prionospio krusadensis*
Prostomium rounded, but slightly notched in front and prolonged up to the 3rd segment ... . *Polydora ciliata*

FAMILY 9. CAPITELLIDAE

1. Thorax with seven segments; dorsal and ventral hooks begin from tenth segment; gills present in posterior segments .... *Branchiocapitella singularis*
Thorax with more than seven segments 2
2. Thorax with 11 segments; segments one to five capillary setae; segments six to 11 long hooks; short hooks in the rest ..... *Heteromastus similis*
Thorax with 12 segments; segments two to seven capillary setae; eight to 12 long crochets; short crochets in the rest .... *Barantolla sculpta*

FAMILY 10. MALDANIDAE

Head with cephalic plate; anal segment with anal cirri; total segments 19. Ocelli present in cephalic plate; median ventral cirrus in caudal funnel stouter than others
.... *Euclymene annandalei*
Absence of ocelli in cephalic plate; median ventral cirrus in caudal funnel longer than others .... *Euclymene insecta*

FAMILY 11. AMPHARETIDAE

Thorax 17 segments; gills four pairs and arranged on either side of the first two segments...... .... *Amphecteis gunneri*

FAMILY 12. SABELLIDAE

Thorax six segments; no pickaxe-shaped setae; ranchiae four pairs .... *Laonome indica*
Thorax seven segments; presence of pickaxe-shaped setae; Branchiae six pairs .... *Potamilla leptochaeta*

FAMILY 13. SERPULIDAE

Operculum compound; funnel shaped with a crown of horny spines; radii of operculum sharp with more than one pair of lateral processes .... *Hydroides norvegica*

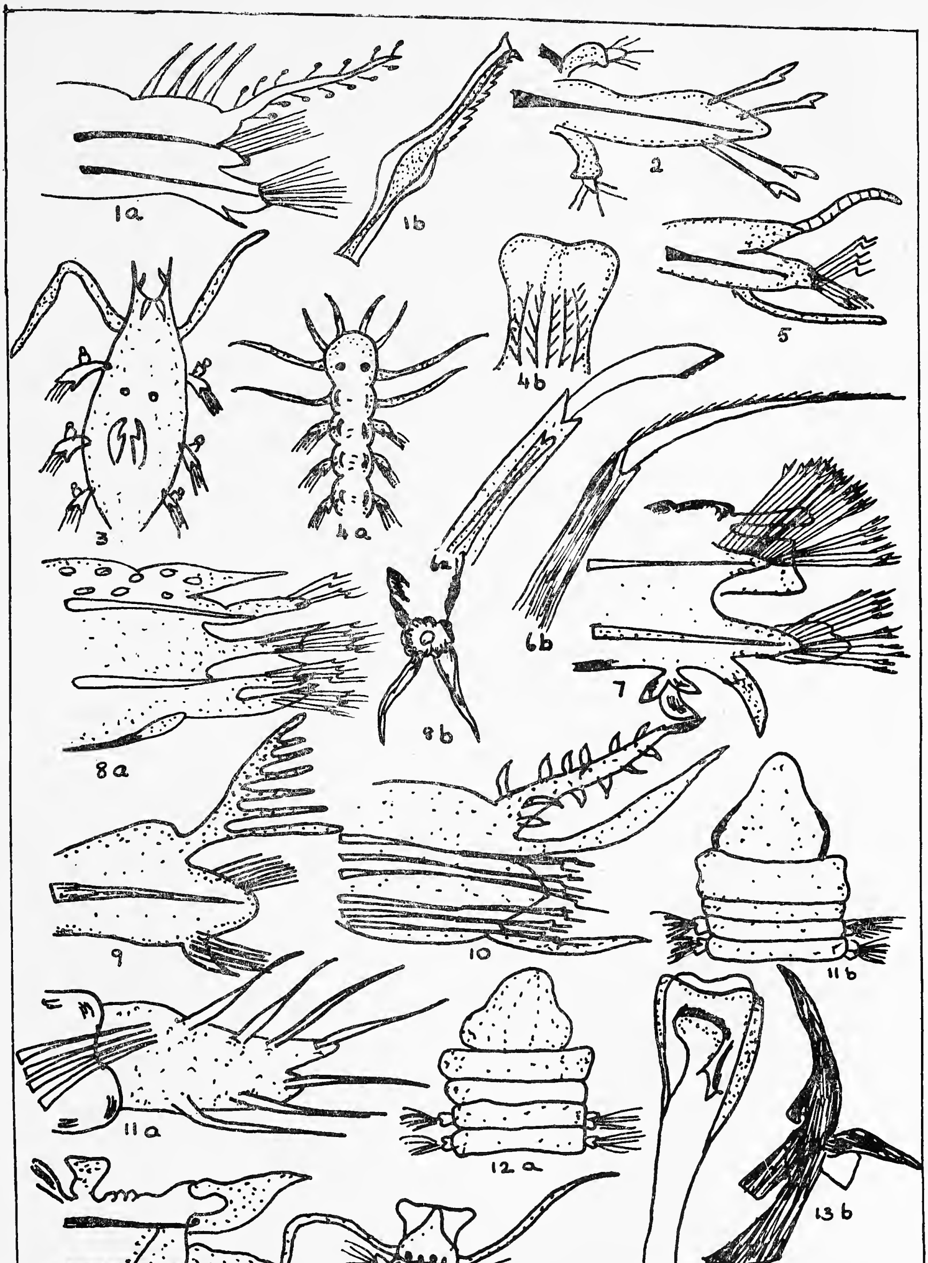
TAXONOMY

ERRANTIA

FAMILY APHRODITIDAE

Species 1. **Harmothoe ampullifera** (Grube) 1878 (Plate 3, figs. 1a & 1b)

Polynoe ampullifera Grube 1878, p. 35; *Lepidonotus ampullifera* Gravier 1901, p. 214; *Harmothoe ampullifera* Fauvel 1911, p. 368; *Paralepidonotus ampullifera* Horst 1917, p. 76; *Harmothoe ampullifera* Fauvel 1927, p. 414; 1930a, p. 8; 1930b, p. 508; 1932, p. 22; 1940, p. 254; 1953, p. 43-44; De Silva 1965, p. 538-539; Pillai 1965, p. 117-119. Parulekar 1971, p. 732.



(*see* captions overleaf)

Captions to Plate 3

Harmathoe ampullifera Grube, 1878
Fig. 1a — Median foot;
Fig. 1b — Ventral seta.

Pisionidens indica Aiyar & Alikunhi, 1940
Fig. 2 — A typical parapodium.

Pisione complexa Alikunhi, 1947
Fig. 3 — Anterior end, Dorsal view.

Eteone barantollae Fauvel, 1932.
Fig. 4a — Head, Dorsal view;
Fig. 4b — Proboscis with rows of papillae.

Hesione intertexta Grube, 1878
Fig. 5 — Median parapodium.

Lycastis indica Southern, 1921
Fig. 6a — Heterogomph falciger from median parapodium;
Fig. 6b — Homogomph spiniger from same parapodium.

Nereis chilkaensis Southern, 1921.
Fig. 7 — Median right foot.

Tylonereis fauveli Southern, 1921
Fig. 8a — 5th right foot;
Fig. 8b — posterior end, Dorsal view.

Marphysa gravelyi Southern, 1921
Fig. 9 — Branchiate foot.

Diopatra neapolitana Delle Chiaje, 1941
Fig. 10 — 10th right foot with gills.

Lumbriconereis simplex Southern, 1921
Fig. 11a — Anterior foot;
Fig. 11b — Anterior end, Dorsal view.

Lumbriconereis polydesma Southern, 1921
Fig. 12a — Anterior end, Dorsal view;
Fig. 12b — Tip of crochet from median parapodium.

Glycera alba Rathke, 1843
Fig. 13a — 8th right foot;
Fig. 13b — jaw enlarged.

Nerine cirratulus Delle Chiaje, 1828.
Fig. 14a — Anterior end, Dorsal view;
Fig. 14b — Ventral bidentate hooded hook.

Habitat. Collected from within the crevices of oyster shells.

Description. Length 25 to 35 mm, including parapodia on either side. Elytra 15 pairs, overlapping each other posteriorly. Total number of parapodia 37 pairs. Dorsal setae slightly curved and serrated. Ventral setae long and bidentate. Tentacles black in colour.

Occurrence in Indian waters. Madras, Rameswaram and Pamban (coral reefs).

Distribution outside Indian waters. Philippine Islands, Persian Gulf and Red Sea.

Remarks. This species is closely related to *Harmothoe imbricata,* but it differs from that in having elongated nephridial papillae and ventral lamellae.

Family Pisionidae

Species 2. **Pisionidens indica** Aiyar & Alikunhi 1940
(Plate 3, fig. 2)

Pisionella indica Aiyar & Alikunhi 1940, p. 89; *Fauviella pulchra* Tebble 1953, p. 938; *Pisionidens pulchra* Day 1957, p. 68; *Pisionidens indica* Day 1962, p. 636.

Habitat. Pulicat Mouth (Interstitial).

Description. 7 to 12 mm in preserved condition. Body consists of about 35 segments. Prostomium highly reduced. Eyes not clearly visible. Parapodia uniramous.

Occurrence in Indian waters. Indian Ocean and Bay of Bengal.

Distribution outside Indian waters. Durban and West Indian Ocean.

Remarks. The forms described here are not fully grown. In fully grown forms the third to sixth parapodia are non-setigerous, setae present from the seventh segment only. However in this juvenile, almost all the parapodia bear compound as well as simple setae.

Species 3. **Pisione complexa** Alikunhi 1947
(Plate 3, fig. 3)

Pisione complexa Alikunhi 1947, p. 105; Rao & Ganapathi 1968, p. 110.

Habitat. Collected from Pulicat Pass (Interstitial).

Description. 6 to 10 mm long, possessing about 40 segments. Two non-serrated buccal spines present between the two palps. A pair of eyes present. Parapodia uniramous. Each parapodium bears two long acicula and five setae, both of simple and compound types. The anal segment bears a pair of long anal cirri. Genital papillae are seen in the 35th segment.

Occurrence in Indian waters. Madras beach, Waltair coast.

Distribution outside Indian waters. Bay of Bengal.

Remarks. Out of the 15 worms collected only 4 worms possess anal cirri. In all the others, the anal cirri are absent.

Family Phyllodocidae

Species 4. **Eteone barantollae** Fauvel 1932
(Plate 3, figs. 4a & 4b)

Eteone barantollae Fauvel 1932, p. 72; 1953, p. 127.

Habitat. Collected from Pulicat Pass area, along with *Pisione complexa* and some nematodes.

Description. Length 10 to 15 mm; breadth 1 to 1.5 mm. The worm possesses about 90 segments. A pair of eyes present. Proboscis bears rows of papillae. Simple setae absent. Paired anal cirri present.

Occurrence in Indian waters. Saltwater lakes near Calcutta.

Distribution outside Indian waters. Not known.

Remarks. Only two worms were collected by Fauvel (1932 & 1953) who described that there are five rows of papillae on the proboscis.

But in the present collection, the papillae are not arranged in five definite rows, but are seen to be rather irregularly arranged.

Family Hesionidae

Species 5. **Hesione intertexta** Grube 1878
(Plate 3, fig. 5)

Hesione intertexta Grube 1878, p. 102; Chamberlin 1919, p. 188; Monro 1926; p. 311; Pruvot 1930, p. 29; Fauvel 1932, p. 60; Monro 1937, p. 270; Fauvel 1953, p. 105; Tampi 1964, p. 104.

Habitat. Collected from the crevices of oyster shells.

Description. Prostomium bilobed. Two pairs of eyes present. A pair of tentacles and eight pairs of tentacular cirri present with cirratophores. Parapodia uniramous. Setae sickle-shaped. Total segments 16. Proboscis unarmed. Segments distinct at the sides.

Occurrence in Indian waters. Gulf of Mannar, Port Blair, West Indian Ocean.

Distribution outside Indian waters. New Caledonia, Philippine Islands, Australia.

Remarks. These worms were collected along with *Harmathoe ampullifera.*

Family Nereidae

Species 6. **Lycastis indica** Southern 1921
(Plate 3, figs. 6a & 6b)

Lycastis indica Southern 1921, p. 578; Horst 1924, p. 4; Fauvel 1930a. p. 19; 1932, p. 82; Aziz 1938, p. 27; Fauvel 1940, p. 257; 1953, p. 167; Ghosh 1963, p. 240; De Silva 1965, p. 5.

Habitat. This species is an euryhaline form. It was collected from Sattankuppam, Lighthousekuppam and Edamani on the Pulicat Lake.

Description. Length 30 to 40 mm and consists of about 130 setigerous segments. Proboscis without paragnaths. Jaws possess nine teeth. Feet uniramous. In larger specimens, the dorsal cirri are long and finger-shaped. The dorsal cirri consist of a few homogomph spinigerous setae. The ventral tuft bears both heterogomph, spinigerous and heterogomph falcigerous setae.

Occurrence in Indian waters. Chilka Lake, Salt lakes (Calcutta), Cochin, Madras, Travancore, Kilakarai, Waltair and Porto-Novo.

Distribution outside Indian waters. Not known.

Remarks. Southern (1921) describes the dorsal longitudinal groove ending in a pit, but the Pulicat species do not show this pit.

Species 7. **Nereis chilkaensis** Southern 1921
(Plate 3, fig. 7)

Nereis chilkaensis Southern 1921, p. 584; Fauvel 1932, p. 94; Panikkar & Aiyar 1937, p. 293; Fauvel 1940, p. 258; 1953, p. 185; De Silva 1965, p. 543; Parulekar 1971, p. 739.

Habitat. This species is available in almost all regions of the Pulicat Lake except at the pass. It lives in burrows and occasionally comes out to the surface of the water.

Description. Length 50-75 mm and consists of about 75 segments. Characters are very similar to those of Southern's (1921) description. Feet biramous. Each foot bears about 40-50 setae in general. Variations may occur due to the varying degrees of sexual maturity.

Occurrence in Indian waters. Chilka Lake, Ennur backwater, Pamban, Madras coast and Travancore.

Distribution outside Indian waters. Sri Lanka.

Remarks. The colour of the worm varies in different areas of the lake.

Species 8. **Tylonereis fauveli** Southern 1921
(Plate 3, figs. 8a & 8b)

Tylonereis fauveli Southern 1921, p. 582; Fauvel 1930a, p. 19; 1932, p. 84; 1953, p. 169.

Habitat. It was collected at the following stations : Venadu, Berupet, Sriharikota, Atakanitippa and Royduruah.

Description. Length 40-80 mm and consists of about 125 segments. Eyes black. Tentacles, palps and tentacular cirri well developed. Feet biramous, setae arranged in three groups. Anal segment bright red in colour.

Occurrence in Indian waters. Chilka Lake and Pamban.

Distribution outside Indian waters. Mergui.

Remarks. This species has more resemblance to *Tylonereis bogoyawlonskyi* Fauvel (1911), but it differs from the latter in having a bilobed ventral setigerous neuropodium, instead of a trilobed one. The worms are pale pink in colour.

Family Eunicidae

Species 9. **Marphysa gravelyi** Southern 1921 (Plate 3, fig. 9)

Marphysa gravelyi Southern 1921, p. 617; Gravelyi 1927, p. 19; Fauvel 1932, p. 142; Aiyar 1933, p. 207; Fauvel 1953, p. 246; Krishnamurthy 1963, p. 97; Pillai 1965, p. 110-177; Cheriyan 1966, p. 44.

Habitat. These worms live in long burrows in muddy bottom of the Pulicat Lake. Their burrows are not vertical but pass through the soil irregularly in various directions. The openings of their burrows can be easily located by the presence of a circular ridge of fine sand all round. During breeding season one can notice the large cucumber-shaped egg mass of jelly, attached to the mouth of each burrow. These worms were collected from the stations Sattankuppam, Lighthousekuppam, Edamani, Kottaikuppam lock, Avarivakkam, Dhonirevu, Annamalaicheri, Moosamani lock, Arangam, Chunnambukulam, Arambakkam, Irakkam, Malan, Dugirajapatnam and Royduruah.

Description. Large specimens measure about 300 mm and carry about 500 segments. Anterior end slightly cylindrical up to the 7th segment behind which it is depressed. Anterior region greenish in colour, posterior region blood-red in colour. Gills vary from blood-red to pale yellow. Out of the five tentacles the middle one is the longest. In general, two eyes present in young individuals. Two pairs of anal cirri, of which one pair larger than the other. Dental apparatus similar to Southern's (1921) description. Feet highly vascularised; setae arranged in two groups; capillary type. Their length varies very much. The blades very minutely serrated.

Occurrence in Indian waters. Chilka Lake, Adyar estuary, Ennur backwaters, Vellar estuary and Cochin harbour area.

Distribution outside Indian waters. Philippines and Indonesia.

Remarks. Eyes are usually said to be absent in adults, but they are well developed in the adults of Chunnambukulam and Pulincheri stations. However, adults from Edamani, Lighthousekuppam and Sattankuppam do not possess eyes. This is an instance of intraspecific variation.

Species 10. **Diopatra neapolitana** Delle Chiaje 1841 (Plate 3, fig. 10)

Diopatra neapolitana Delle Chiaje, 1841; Mc Intosh 1903, p. 128; Crossland 1903, p. 132; *Diopatra amboensis* Willey 1905, p. 274;*Diopatra variabilis* Southern 1921, p. 611; *Diopatra neapolitana* Fauvel 1923, p. 419; 1930, p. 29; 1932, p. 144; 1933, p. 28; Monro 1933, p. 293; Aziz 1938, p. 39; Fauvel 1953, p. 252; Tebble 1955, p. 116; Pillai 1961, p. 13; Cheriyan 1966, p. 45; *Diopatra variabilis* Hartman 1974, p. 223.

Habitat. It was collected at the Pulicat Pass, Karimanal, Kottaikuppam lock, Kulathumedu and Pakkam.

Description. Purple-green in colour. Up to 250 mm and consists of about 320 segments. Out of the five occipital tentacles the median one can be stretched up to the middle of the 10th segment. All tentacles bear cirratophores. Eyes absent. Gills begin from the fourth foot only. Gill filaments spirally arranged. There is

no variation in the dental apparatus from Southern's description. The tube is membranous and partly buried in sand, the upperpart thick, tough and more or less encrusted with broken pieces of molluscan shells.

Occurrence in Indian waters. Gangetic delta, Orissa coast, Madras coast, Gulf of Mannar and Cochin harbour area.

Distribution outside Indian waters. Pacific Ocean, China Sea, Gulf of Siam, Arabian Sea, Gulf of Oman, Persian Gulf, Red Sea, Atlantic Ocean and the Mediterranean Sea.

Remarks. According to Fauvel (1953), there is not much difference between *Diopatra neapolitana* Delle Chiaje 1841, and *Diopatra variabilis* Southern 1921 except for the teeth in comb setae.

Species 11. **Lumbriconereis simplex** Southern 1921
(Plate 3, figs. 11a & 11b)

Lumbriconereis simplex Southern 1921, p. 625; Fauvel 1953, p. 264; Cheriyan 1966, p. 46.

Habitat. Available at Dhonirevu only and is collected along with *Euclymene annandalei.*

Description. Prostomium conical. Eyes, palps and tentacles absent. Feet highly vascularised. Parapodia absent in the first two segments. Setae simple winged, capillary type. There is not much variation in the pharyngeal complex from Southern's (1921) description. Length 15 to 30 mm., breadth about 2 mm.

Occurrence in Indian waters. Saltwaters of Calcutta, Chilka Lake and Cochin harbour.

Distribution outside Indian waters. Not known.

Remarks. According to Southern (1921), there is a dark amber coloured spot near the base of each foot. Such spots are not observed in the Pulicat forms.

Species 12. **Lumbriconereis polydesma** Southern 1921
(Plate 3, figs. 12a & 12b)

Lumbriconereis polydesma Southern 1921, p. 632; Panikkar and Aiyar 1937; Fauvel 1953, p. 264.

Habitat. Available only at Dhonirevu.

Description. Prostomium round; eyes absent. Two achaetous rings between the head and 1st setigerous segment. Feet increase in size up to the 10th segment and then taper gradually towards the posterior end. Hooks present from the 29th feet. Hooks or crochets have two broad wings over the tip with delicate striations. The setae are stout winged capillaries.

Occurrence in Indian waters. Chilka Lake.

Distribution outside Indian waters. Not known.

Remarks. According to Southern (1921), there is a small patch of pigment near the posterior border of the head, a little on the right side of the median line. Such a pigment patch is not observed in the Pulicat forms.

FAMILY GLYCERIDAE

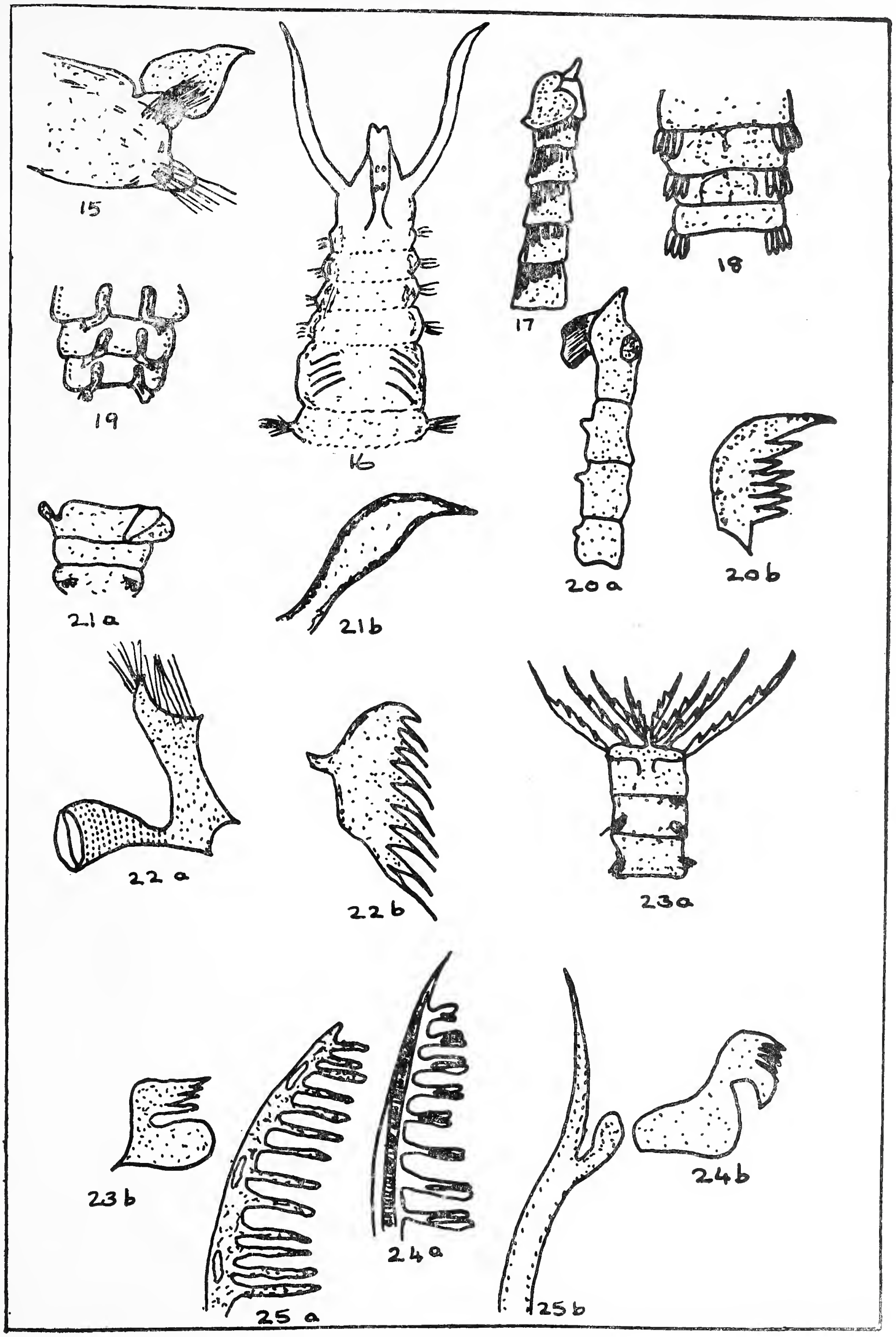
Species 13. **Glycera alba** Rathke 1843
(Plate 3, figs. 13a & 13b)

Glycera alba Ehlers 1868, p. 661; Moore 1903, p. 464; Izuka 1912, p. 247; var. *cochinensis* Southern 1921, p. 627; Fauvel 1923, p. 385; Gravely 1927, p. 9; Fauvel 1932, p. 126; Aziz 1938, p. 31; Fauvel 1940, p. 261; 1953, p. 292; Cheriyan 1966, p. 47; Parulekar 1971, p. 745.

Habitat. This form is confined to Pulicat Pass (sandy beach) only.

Description. Length 50 to 60 mm about 100 setigerous segments. Body rounded, prostomium conical and pointed with four small tentacles. Proboscis with four hooked jaws and well developed papillae. Gills simple and inserted on the dorsal side of the parapodia. Anal segment bears a pair of long tapering cirri. Dorsal setae simple, ventral setae compound.

Occurrence in Indian waters. Ganjam coast, Cochin backwater and Mormugoa Bay.



(*see* captions overleaf)

Captions to Plate 4

Prionospio krusadensis Fauvel, 1929
Fig. 15 — Median parapodium.

Polydora ciliata Johnston, 1838
Fig. 16 — Anterior end, Dorsal view.

Heteromastus similis Southern, 1921
Fig. 17 — Anterior end, side view.

Barantolla sculpta Southern, 1921
Fig. 18 — Dorsal view of segments with branchiae.

Branchiocapitella singularis Fauvel, 1932
Fig. 19 — Dorsal view of segments with branchial lobes.

Euclymene annandalei Southern, 1921
Fig. 20a — Anterior end, lateral view;
Fig. 20a — Uncinus of the 10th segment.

Clymene (*Euclymene*) *insecta* Ehlers, 1904
Fig. 21a — Anterior end, side view;
Fig. 21b — Acicular hook.

Amphicteis gunneri Sars, 1851
Fig. 22a — Thoracic foot with dorsal cirrus and pinnules;
Fig. 22b — Thoracic uncinus.

Laonome indica Southern, 1921
Fig. 23a — Anterior end, Dorsal view;
Fig. 23b — Thoracic uncinus.

Potamilla leptochaeta Southern, 1921
Fig. 24a — Tip of a gill;
Fig. 24b — Avicular uncinus.

Hydroides norvegica Gunnereus, 1768
Fig. 25a — A single radiole enlarged;
Fig. 25b — Baynet shaped bristle.

Distribution outside Indian waters. Red Sea, Atlantic Ocean and Indian Ocean.

Remarks. The worms are milky white in colour.

SEDENTARIA

Family Spionidae

Species 14. **Nerine cirratulus** Delle Chiaje 1828 (Plate 3, figs. 14a & 14b)

Nerine cirratulus Fauvel 1927a, p. 36; 1953, p. 312; Day 1962, p. 648; De Silva 1965, p. 553.

Habitat. These forms are available only on the sandy shores of the Kottaikuppam lock but completely absent in the muddy areas.

Description. Worms bright red up to the anterior 30 segments, rest bluish green in colour. Length 30-50 mm. Prostomium with two long tentacle-like palps. A single occipital tentacle-like keel. Four large eyes arranged in a single transverse row. Gills begin from the second setigerous segment, absent in the few posterior segments. Dorsal lamellae long in the anterior region but short in the posterior region. Ventral lamellae narrow. Feet biramous and possess winged capillary setae. The hooded hooks begin from the 30th segment. The tip of the hooks is bidentate. Their number varies in various segments.

Occurrence in Indian waters. Vishakapatnam channel, Sri Lanka, Indian Ocean.

Distribution outside Indian waters. Atlantic Ocean, Mediterranean Sea and Madagascar.

Remarks. This form differs from Fauvel's (1953) description in the following characters.

1. The colour of the Pulicat form is red up to the first 30 segments and the rest of the segments are bluish green in colour, but the whole worm is bluish green in colour according to Fauvel.
2. Four eyes are arranged in a transverse row in the Pulicat forms. They are arranged in a trapezium according to Fauvel's description.
3. The posterior occipital peak is not well developed in the Pulicat forms. According to Fauvel's description, this reaches upto the second segment.

Species 15. **Prionospio krusadensis** Fauvel 1929 (Plate 4, fig. 15)

Prionospio krusadensis Fauvel 1929, p. 182; 1930, p. 38; 1953; p. 326.

Habitat. This form is available only in the sandy shores of the Pulicat Pass.

Description. Body slender, anterior region slightly enlarged. Prostomium long and rounded. Four small eyes arranged in a trapezium. Branchiae arise from the second setigerous segment onwards. Gills large and oval in shape. Setae are capillary. Ventral hooks begin from the 18th segment onwards. Dorsal hooks begin from the 40th foot. Hooks bear three teeth. Median anal cirrus present. Length 30 to 50 mm. Breadth about 2 mm.

Occurrence in Indian waters. Gulf of Mannar, Krusadai Island.

Distribution outside Indian waters. Not known.

Remarks. These forms are milky white in colour but turn yellow in alcohol.

Species 16. **Polydora ciliata** Johnston 1838 (Plate 4, fig. 16)

Polydora ciliata Fauvel 1927a, p. 49; Panikkar and Aiyar 1937; p. 293; Fauvel 1953, p. 319.

Habitat. This species was collected from the oyster bed area, along with serpulids and sabellids.

Description. Prostomium slightly notched in front and prolonged backwards upto the 3rd segment. Four small eye-spots present on dorsal side. No dorsal setae on the 1st setigerous segment. Ventral capillary setae well developed. Ventral bidentate hooks present on the

7th setigerous segment. Gills from the 7th segment onwards.

Occurrence in Indian waters. Chandipore, Orissa coast and Mangalore coast.

Distribution outside Indian waters. Australia, Indo-China, Red Sea, Atlantic Ocean, Mediterranean Sea and Falkland Islands.

Remarks. Though they are small in size (25mm/1mm), they are capable of producing mud-blisters in the mantle of the edible oyster, *Crassostrea madrasensis* (Stephen, 1978b). They are considered as pests of bivalves. Their burrow is U-shaped. Although another closely related species *Polydora kempi* was recorded by Chacko *et al.* (1953) in Pulicat Lake, during the course of the present investigation over a period of seven years it was not possible to record this species.

Family Capitellidae

Species 17. **Heteromastus similis** Southern 1921 (Plate 4, fig. 17)

Heteromastus similis Southern 1921, p. 640; Gravely 1927, p. 26; Fauvel 1930a, p. 46; 1932, p. 195; 1953, p. 366; De Silva 1965, p. 554.

Habitat. This is widespread in Pulicat Lake.

Description. Bright red in colour and consist of about 200 to 220 segments. Length 60 to 70 mm. The anterior end enlarged and gradually tapers towards the tail. Peristomium long and achaetous. Thorax of 11 segments. Segment two to the sixth possess short capillary setae. Gills absent. Anal segment bears a slender clavate tail. Posterior segments possess dorsal hooks in each foot. The hook has two large teeth and one small one.

Occurrence in Indian waters. Chilka Lake, Vishakapatnam and Gulf of Mannar.

Distribution outside Indian waters. Teleh-Sap, Gulf of Siam.

Remarks. These are very closely related to *Heteromastus filiformis* Claperede (1864). The head as well as the arrangement and structure of the setae are almost identical. In *H. filiformis,* the anterior abdominal segments are much longer than the thoracic segments, whereas in *H. similis* the segments do not differ in length.

Species 18. **Barantolla sculpta** Southern 1921 (Plate 4, fig. 18)

Barantolla sculpta Southern 1921, p. 643; Fauvel 1932, p. 196; 1953, p. 370.

Habitat. These forms were collected from Gunankuppam along with *Heteromastus similis* from the dark mud.

Description. Reddish brown in colour, about 50 mm long by 2 mm. Total number of segments about 60. Body wider near fourth or fifth segment. Eyes absent. First four segments slightly tassellated. Segments two to seven have only capillary setae. Segments eight to twelve possess long crochets. These crochets are short in the abdominal segments. Branchiae arise from the 56th segment onwards. They lie under the dorsal parapodial lobes. Number of branchiae is more towards the anal end. Anal cirrus single and median. 12 thoracic segments.

Occurrence in Indian waters. Barantolla near Calcutta.

Distribution outside Indian waters. Taleh-Sap, Gulf of Siam.

Remarks. The head is contracted and withdrawn under the peristomium. According to Southern (1921), there are 12 thoracic segments, but in Pulicat forms they are not very distinct from the abdominal segments.

Species 19. **Branchiocapitella singularis** Fauvel 1932 (Plate 4, fig. 19)

Branchiocapitella singularis Fauvel 1932, p. 197; 1953, p. 371; De Silva 1965, p. 555; Pillai 1965, p. 110-177.

Habitat. These worms are available only in

the dark sand near the Lighthousekuppam area.

Description. Total length 50 to 60 mm/ 2 mm. Body slender and slightly enlarged in the thorax. Seven thoracic segments. Dorsal and ventral hooks start from the tenth segment onwards. Gills present nearer the anal segments only. Pygidium ends in a bilobed knob.

Occurrence in Indian waters. Porto-Novo and Vishakapatnam.

Distribution outside Indian waters. Sri Lanka.

Remarks. The copulatory spines described by Fauvel (1953) are not seen on the eighth and ninth segments.

Family Maldanidae

Species 20. **Euclymene annandalei** Southern 1921

(Plate 4, figs. 20a & 20b)

Euclymene annandalei Southern 1921, p. 648; Fauvel 1932, p. 199; 1953, p. 377.

Habitat. They live in sandy tubes and from the dark muddy areas of the Pulicat Lake, namely from Sattankuppam, Lighthousekuppam, Avarivakkam, Dhonirevu and Moosamani Lock.

Description. Length 20 to 60 mm. Total segments 21, of which two achaetous. Head carries the cephalic plate. Numerous ocelli. Caudal funnel bears short, bluntly rounded cirri. Parapodia very close to Southern's description.

Occurrence in Indian waters. Vellar Estuary, Kakinada Bay and Chilka Lake. Camorta, Andaman and Nicobar Islands.

Distribution outside Indian waters. Amoy (China).

Remarks. The sandy tubes are not as brittle as Southern (1921) has stated. The segmentation is very distinct.

Species 21. **Clymene (Euclymene) insecta** (Ehlers) 1904

(Plate 4, figs. 21a & 21b)

Clymenella insecta Ehlers 1904, p. 54; *Paraxillella insecta* Augener 1926a, p. 192; *Clymene* (*Euclymene*) *insecta* Fauvel 1932, p. 199; 1953, p. 377; Krishnamurthy 1963, p. 95.

Habitat. This also lives in sandy tubes. This is available only from the Chunnambukulam area.

Description. Bright red in colour. Body delicate, total number of segments about 22. Nuchal grooves not clearly seen. Prostomium does not bear any appendages other than the cephalic plate. The caudal funnel possesses a number of short cirri, of which one is longer than the others. The first three setigerous segments possess acicular hooks. Fourth to seventh segments bear hooded hooks with two to three teeth. Capillary and capillary wing setae present from the eighth segment onwards.

Occurrence in Indian waters. Vishakapatnam and Madras.

Distribution outside Indian waters. New Zealand.

Remarks. Caudal funnel is similar to that of *Euclymene annandalei,* but it differs in having a longer median ventral cirrus. In *E. annandalei,* the median ventral cirrus is slightly stouter than in others.

Family Ampharetidae

Species 22. **Amphicteis gunneri** Sars 1835

(Plate 4, figs. 22a & 22b)

Amphicteis gunneri Malmgren 1865, p. 365; *Amphicteis japonica* McIntosh 1885, p. 431; *Amphicteis gunneri* Fauvel 1897, p. 411; Hessle 1917, p. 116; 1927, p. 231; 1932, p. 216; Monro 1933, p. 313; Fauvel 1953, p. 407; Day 1967, p. 695.

Habitat. These forms were collected from the crevices of oyster shells.

Description. Body divided into thorax and abdomen. Thorax bears 17 segments and abdomen bears about 15 to 25 segments. Eyes or eye-spots completely absent. Thorax possesses dorsal capillary setae and ventral uncinigerous pinnules. Abdomen bears only

uncinigerous pinnules. Four pairs of gills present. Anal segment does not bear anal cirri. Tube is muddy and the length varies from 40 to 60 mm.

Occurrence in Indian waters. Bay of Bengal, Orissa coast.

Distribution outside Indian waters. Gulf of Oman, Japan, Indo-China, Atlantic Ocean, Mediterranean Sea and Antarctic Ocean.

Remarks. The worms are pink in colour. According to Fauvel (1953), there are numerous eye-spots. Pulicat forms do not possess any eye-spots.

Family Sabellidae

Species 23. **Laonome indica** Southern 1921 (Plate 4, figs. 23a & 23b)

Laonome indica Southern 1921, p. 652; Fauvel 1953, p. 446.

Habitat. This was collected from the Kulathumedu station, from within the crevices of oyster shells.

Description. Very thin, about 50 segments. Posterior ten segments shorter than anterior ones. Only four pairs of branchial lobes instead of seven as Southern (1921) describes, but they are symmetrical. Eyes completely absent. Thorax composed of about six segments. The abdominal segments possess uncini. The arrangement of setae agrees with Southern's (1921) description.

Occurrence in Indian waters. Chilka Lake.

Distribution outside Indian waters. Not known.

Remarks. The colour is brown in live condition, but it turns pale when preserved in 5% formalin.

Species 24. **Potamilla leptochaeta** Southern 1921 (Plate 4, figs. 24a & 24b)

Potamilla leptochaeta Southern 1921, p. 651; Gravely 1927, p. 27; Fauvel 1932, p. 231; Aziz 1938, p. 47; Fauvel 1953, p. 449; De Silva 1965, p. 559.

Habitat. It is commonly available at Moosamani lock, Lighthousekuppam and at Gunankuppam stations.

Description. 20-30 mm long. Prostomium bears about 10 to 12 branchiae. Each branchia possesses about 40-45 filaments. Gills without eyes. Colour of the worm differs from Southern's (1921) description. All the worms are pale green with white stripes. The arrangement of setae agrees with Southern's (1921) description. Tube is made up of mud and sand.

Occurrence in Indian waters. Chingrighatta near Calcutta and Vishakapatnam.

Distribution outside Indian waters. Malay Archipelago.

Remarks. This species closely resembles *Potamilla ceylonica* Augener (1926), but it differs from *P. ceylonica* with regard to the arrangement of setae in both the thoracic as well as in the abdominal segments.

Family Serpulidae

Species 25. **Hydroides norvegica** Gunnerus 1768 (Plate 4, figs. 25a & 25b)

Eupomatus elegans Haswell 1883, p. 633; *Hydroides multispinosa* Marenzeller 1884, p. 21; *Hydroides norvegica* Pixell 1913, p. 74; *Hydroides multispinosa* Augener 1914, p. 139; *Hydroides norvegica* Fauvel 1927a, p. 356; 1932, p. 242; 1953, p. 458; Pillai 1960, p. 12.

Habitat. Large numbers of the tubes of this species were collected from the crevices of oyster shells at the Kulathumedu station, but worms were present only in some tubes.

Description. 20-25 mm long. Tubes white, cylindrical and more or less erect. Gills around the mouth, bearing numerous radicles with two rows of barbules. Thorax possesses dorsal capillary setae and ventral uncinigerous tori, but the abdominal segments possesses dorsal

uncinigerous tori and ventral capillary setae. Operculum well developed.

Occurrence in Indian waters. Madras.

Distribution outside Indian waters. Persian Gulf, Red Sea, Atlantic Ocean and Mediterranean Sea.

Remarks. These worms are purely marine and sedentary forms.

Distribution and Ecology

The two major factors which influence the distribution pattern of the polychaetes in the Pulicat Lake are salinity and the nature of the substratum. On the basis of salinity, the lake may be divided broadly into three habitats, namely marine, brackishwater, and freshwater habitat.

The marine habitat includes stations like the Pulicat pass, Karimanal, Gunankuppam, Lighthousekuppam, Kottaikuppam lock and Dhonirevu. The polychaetes collected at these stations include mostly marine forms (Table 2). The salinity at these stations ranges from 25.31‰ to 38.45‰.

The brackishwater habitat includes the rest of the stations, except the stations in the three river beds, namely the Araniar river, Kalinga river and the Swarnamuki river. The average salinity at the brackishwater stations varies from 11.65‰ to 48.51‰. Out of the 14 species collected from this habitat, *Nerine cirratulus* was collected only from the Kottaikuppam lock and *Lumbriconereis simplex* and *Lumbriconereis polydesma* were collected only from Dhonirevu. This shows that these three species are designed to live at these stations alone, mainly because of the nature of the substratum rather than the salinity at these stations.

The freshwater habitats of the Swarnamuki river, Kalinga river and the Araniar river have the river bed mostly sandy and in some places it is muddy. Distribution pattern of the polychaete worms in the freshwater habitat is mainly controlled by salinity. The polychaetes collected in the freshwater habitat are *Marphysa gravelyi, Nereis chilkaensis, Lycastis indica, Heteromastus similis, Potamilla leptochaeta,* and *Diopatra neapolitana.* The species *Potamilla leptochaeta* and *Diopatra neapolitana* were not available during the monsoon season in the freshwater habitat. This might have been due to the lowering of salinities of the river water during such monsoon seasons.

Besides salinity the other major factor determining the distribution of the polychaetes in Pulicat Lake is the nature of the substratum. On the basis of the type of substratum, Pulicat Lake may be considered to have four types of substrata for polychaetes, namely sandy, sand-silt, weedy and the oyster-bed substrata.

The sandy substratum in Pulicat Lake is distributed at the following stations, namely Pulicat Pass, Karimanal, Dhonirevu, Gunankuppam, Lighthousekuppam, Kottaikuppam lock, Irakkam, Venadu, Sriharikota and Atakanitippa. Interstitial polychaetes like *Pisione complexa, Pisionidens indica* and *Eteone barantollae* were collected only from such sandy substratum. Other polychaetes in sandy substratum include *Glycera alba, Prionospio krusadensis, Tylonereis fauveli, Euclymene annandalei* and *Euclymene insecta.*

The sand-silt substratum is observed at the following stations, namely Annamalaicheri, Arambakkam, Tada, Berupet, Malan, Royduruah, Edamanai and Duggirajapatnam. The muddy substrata at these stations are dark in colour, and possess decayed vegetable matter. The polychaetes collected at these stations were *Marphysa gravelyi, Tylonereis fauveli, Nereis chilkaensis, Lumbriconereis simplex, Lumbriconereis polydesma,* and *Heteromastus similis.* This sand-silt or sand-clay substratum extends over the majority of the lake, and the concentration of the polychaetes was maximum in this type of substratum.

TABLE 2
DISTRIBUTION OF POLYCHAETES IN PULICAT LAKE

	Marine Stations						Brackishwater Stations																		Freshwater Stations		
Species / Stations	Pulicat Pass	Karimanal	Dhonirevu	Gunankuppam	Lighthousekuppam	Kottaikuppam lock	Koraikuppam	Sattankuppam	Edamani	Kulathumedu	Moosamani lock	Annamalaicheri	Chunnambukulam	Arangam	Pulincheri	Zonangipalam	Arambakkam	Irrakkam	Venadu	Berupet	Atakanitippa	Malan	Sriharikotta	Royduruah	Avarivakkam	Tada	Duggirajapatnam
1. *Harmathoe ampullifera*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2. *Pisionidens indica*	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3. *Pisione complexa*	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4. *Eteone barantollae*	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5. *Hesione intertexta*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6. *Lycastis indica*	–	–	–	–	+	–	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7. *Nereis chilkaensis*	–	–	+	+	+	+	+	+	+	+	+	–	+	–	–	+	+	+	–	+	+	+	+	+	+	+	–
8. *Tylonereis fauveli*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+	+	–	+	+	–	–	+
9. *Marphysa gravelyi*	–	–	+	–	+	+	–	+	+	–	+	+	+	+	+	+	+	–	–	–	+	+	–	+	+	+	+
10. *Diopatra neapolitana*	+	+	–	–	–	+	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11. *Lumbriconereis simplex*	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12. *Lumbriconereis polydesma*	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13. *Glycera alba*	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14. *Nerine cerratulus*	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15. *Prionospio krusadensis*	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16. *Polydora ciliata*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
17. *Heteromastus similis*	–	–	–	+	+	–	+	–	+	–	–	+	–	+	+	+	–	–	+	+	–	+	+	+	–	–	+
18. *Barantolla sculpta*	–	–	–	+	+	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–
19. *Branchiocapitella singularis*	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20. *Euclymene annandalei*	–	–	+	+	+	–	–	+	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–
21. *Enclymene insecta*	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22. *Amphicteis gunneri*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23. *Laonome indica*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24. *Potamilla leptochaeta*	–	–	–	+	+	–	+	–	–	–	+	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–
25. *Hydroides norvegica*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

The weedy substratum is observed at a few stations only. Arangam, Pulincheri, Moosamani lock and Zonangipalam are the only four stations where the substratum is covered with weeds. The bottom macrophytes consist mainly of rooted submerged plants like *Halophila ovalis* and *Cymododea isoetifolia* and filamentous algae such as *Chaetomorpha* sp., *Enteromorpha* sp., and *Acetabularia* sp. etc. The marine angiosperm *Halophila ovalis* (Gaud) flourishes in places where soil is dark and clayey. Generally polychaetes are plenty in places where this plant is abundant. Polychaetes are said to be detritus feeders, hence there is some association noticed between polychaetes and this vegetation; perhaps these worms feed on the decayed leaf blades of this plant. *Marphysa gravelyi* in fact was collected more in areas where this plant thrives.

The oyster beds form another kind of substratum in Pulicat Lake. They occur in Kulathumedu village. A number of polychaetes were collected only from the oyster beds. The oysters of Pulicat Lake belong to the species *Crossostrea madrasensis* (Preston) and *Saccostrea cucullata* (Born). The oysters have spread even upto the Kottaikuppam lock. The polychaetes associated with these oysters are *Polydora ciliata, Hydroides norvegica, Amphicteis gunneri, Hesione intertexta, Harmathoe ampullifera, Diopatra neapolitana* and *Nereis chilkaensis.* Out of these, *Hydroides norvegica* and *Polydora ciliata* are encountered more in number. The tubes of *Hydroides norvegica* are chalky white, cylindrical and slightly convoluted. The tubes are more or less erect or sometimes spirally coiled. Atleast eight to ten tubes are found attached to a single oyster shell. *Polydora ciliata* is a spionid polychaete which is also collected in large numbers from this lake. The members of *Polydora* are said to be pests of bivalves. They form mud-blisters on the mantles of bivalves (Stephen, 1978b). It is now considered to be a major problem in coastal shellfish aquaculture.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY — 32

HUMAYUN ABDULALI

MUSCICAPIDAE (Turdinae)

[*Continued from Vol. 83*(2): 359]

This part ending with Synopsis No. 1691 up to Register No. 265171 includes 888 Specimens of 56 species of the Turdinae. There are 8 forms (5 species and 3 subspecies) of which we have no specimens in our collection. Dr (Mrs) S. Unnithan has assisted with the work.

1635 **Brachypterix stellata stellata** Gould (Sikkim) Gould's Shortwing 2:16

nil.

1636 **Brachypterix hyperythra** Jerdon & Blyth (Darjeeling) Rustybellied Shortwing 2:17

1 ♂ (by plumage) Margherita, Assam.

Measurements on p. 117.

1636a. **Brachypterix cryptica** Ripley (40-mile Camp east of Miao, Noa Dihing River, Arunachal Pradesh).

This bird described in 1980 (*JBNHS* 77: p. 1) has been found to be Tickell's Babbler [*Trichastoma tickelli* (Blyth) (*JBNHS* 81 p. 700/1]

1637 **Brachypterix major major** (Jerdon) (Nilgherries) Rufousbellied Shortwing 2:10

2: ♀♀ 1 Avalanche, 6700′, 1 Longwood Shola, Kotagiri, Nilgiri.

Measurements on p. 117.

1638 **Brachypterix major albiventris** (Blanford) (Palni Hills) Whitebellied Shortwing 2:11

2: 1 ♂ 1 ♀

1 Moir Point, 6500′, 1 Kodaikanal 7000′, Palnis.

Measurements on p. 117.

1639 **Brachypterix leucophrys nipalensis** Moore (Nepal) Lesser Shortwing 2:19

9: 2 ♂♂ 6 ♀♀ 1 o?

4 Margherita, Assam; 4 N. Cachar Hills; 1 *Mt. Victoria, Burma.*

Neither of the two males show any blue and Fleming (1970) in BIRDS OF NEPAL, pp. 248 states "birds with blue not yet seen here". Koelz when describing *geokichla* from Manipur (which is not accepted by Ripley) says he examined 11 ♂♂ none of which were blue.

The unsexed bird from Mt. Victoria is the smallest in all respects.

Measurements on p. 117.

1640 **Brachypterix montana cruralis** (Blyth) (Darjeeling) Whitebrowed Shortwing 2:17

11: 6 ♂♂ (1 blue) 5 ♀♀

1* Rangpo, Sikkim; 1 Honka, 1 Gedu, West Bhutan; 1 Darjeeling, 1 Miao, 1 Deban, 1 Firm Base, Arunachal Pradesh; 4 Margherita, Upper Assam.

Five of the six males are in female plumage, but have larger wings, *the one blue bird having the longest. All except one dated 22nd January 1903 show a white streak over the eye.

Measurements on p. 117.

1641 **Erythropygia galactotes familiaris** (Ménétries) (Kur Southern Caucasus) Rufous Chat or Greybacked Warbler 2:386

24: 12 ♂♂ 5 ♀♀ 8 o?

2 *Muscat*; 1 *Feluja*, 1 *Rustem*, 1 *Fahama*, 1 *Baghdad*, 5 *Basra*, *Mesopotamia*; 1 *Shiraz*, 1 *Kasoin*,

8

Persia; 1 Chaman, 1 Kandera Pass, east of Mashkai Valley, Baluchistan; 1 Sakesar, Shahpur Dist., 1 Multan, Pakistan; 4 Bhujia Fort, 1 Nakhatrana, 1 Shinai, Anjar, Kutch; 1 Dwarka, Okhamandel, Kathiawar.

Measurements on p. 117.

EL **Erythropygia galactotes syriacus** Hemprich & Ehrenberg (Beyrouth)

1 ♂ Felujah, Mesopotamia.

This is slightly rufous above and marked "indistinguishable from *syriacus*".

Measurements on p. 118.

1642 **Erithacus megarhynchos hafizi** (Severtzov) (Turkestan) Persian Nightingale 2:87

nil.

EL **Erithacus megarhynchos africana** (Fischer and Reichenow) (Klein Arusha, near Kilimanjara) Nightingale

10: 6 ♂♂ 2 ♀♀ 2 o? (1* fledgling)

1 *Sheikh Saud,* 1 *Fao Iraq*; 2 *Enzeli, Caspian Coast,* 2* *Gulahek, Tehran,* 3 *Shiraz,* 1 *Bog Mizakhani.*

Specimen No. 3174 from Enzeli is marked by Cheesmann "*africana* in song and evidently breeding. This is the new name for the Persian Nightingale *hafizi*". This specimen is very dark and similar to *Luscinia luscinia* but can be separated on the characters mentioned thereunder.

Measurements on p. 118.

1643 **Erithacus calliope** (Pallas) (Yenesei) Rubythroat 2:91

22: 16 ♂♂ (2 by pl.) 4 ♀♀ 2 o?

1 Bharatpur, Rajasthan; 1 Partapur, Nepal; 1 Sirpur, 1* Sarun, 1 Assam; 3 Baghowni, Tirhut; 2 Darbhanga, Bihar & Orissa; 1 Tikerpara, 1 Bhusandpur, Chilka Lake, 2 Mahendragiri, 1 Berbera, Orissa; 2 Sankrametta, 1 Padevalsa, Vizag Dist.; 1 Godavery Delta; 1 Tientsein, 2 *Peking* (cage birds), *China.*

The last two males from Peking have the largest wings — 81 and 82 mm and the chin is pale pink in one and almost white in the other. Other males from Assam, Sarna and Godaveri Delta have pinkish chins but are no larger. The earlier specimens are marked *camschatkensis,* but this race is no longer recognised.

Measurements on p. 118.

Erithacus svecicus BLUETHROATS

This is an extremely difficult group to divide into the many subspecies named, for to quote Vaurie (1959) "Some, perhaps most, of the variation is clinal in some characters but it is complicated by much local variation, seasonal changes in coloration and pattern, and sexual dimorphism in the males of some populations".

Our material consists largely of non-breeding migrants and this makes it more difficult. There has been no alternative but to accept the trinominal identifications made by earlier workers or distributional limits accepted in Indian literature. More extensive ringing accompanied by appropriate collecting may help to clarify matters.

1644 **Erithacus svecicus svecicus** (Linnaeus) (Sweden) Northern Bluethroat 2:83 and 85

10: 9 ♂♂ 1 o?

1 Peshawar, N.W.F.P., 1 Nawashahar, Jullundur, 1 Ambala, Punjab; 1 Sanchi, Bhopal; 1 Baghownie, 2 Madhubani, Darbhanga dist., Bihar; 1 Cawnpur, U.P.; 1 Laisingah, Cachar, 1 *Peking, China.*

Measurements on p. 118.

1645 **Erithacus svecicus pallidogularis** Zarudny (Orenburg, Russia, *c.* 55 E, 52 N.) Turkestan Bluethroat 2: 85

43: 27 ♂♂ 13 ♀♀ 3 o?

3 Chitral, N.W.F.P.; 1 Wana, Waziristan; 8 Ambala, 1 Shikohpur, Jullundur, 1 Campbellpur, 1 Jagadhri, Punjab; 1 Harunabad, Bahawalpur; 1 Kashmir; 1 Badantpur, Bhaji State, Simla Hills; 2 Hamavas Lake, Pali, Jodhpur, Rajasthan; 2 Delhi; 4 Bahawalpur; 1 Kutch; 1 Amreli, Kathiawar, 1 Mehmedabad, Kaira, 1 Ajwa, Baroda, 1 Dohad, Gujerat; 1 Wada, 1 Shil, 1 Murbad, Kalyan, 1 Belapur, 1 Andheri, Bombay; 1 Madhubani, 1 Baghowni, Tirhut, Darbhanga, Behar; 1 Barul, 2 Cawnpur, U.P.; 1 Laisingah, Cachar, 1 *Prome, Burma.*

Measurements on p. 118.

1646 **Erithacus svecicus abbotti** (Richmond) (Nubra Valley, Ladak) Ladakh Bluethroat 2: 86

7: 5 ♂♂ (1 fledgling) 2 ♀♀

2 Panamik, 10800′, 1 Nubra Valley, 1 Kharchar, 11200′, 1 Harje, 9500′, Ladak; 1 Chachran, Bahawalpur State; 1 Ajwa, Baroda.

♂ 26 from Harje, 9500′, shows an ultramarine blue which is brighter than in any of the others available and the black bill 13.2 mm also appears the largest. This has been presented to us by the National Institute of Virology who sent us four for identification.

The others ♂ 3132 from Chachran, Bahawalpur, ♀ 3130 Ajwa, Baroda and ♀ 3131 from Narsampet, all have attenuated bills and have been marked *abbotti* by Meinertzhagen.

All ten, examined including a juvenile with streaks above and below show an attenuated bill, an apparently consistent character.

Measurements on p. 118.

1646a. **Erithacus svecicus saturatior** (Sushkin) (Djoievo, near Minusinsk) Central Asian Bluethroat

8: 7 ♂♂ 1 ♀

1 Darazpur, Ambala, 1 Jagadhri, Punjab; 1 Delhi; 1 Shil, 1 Kalyan, Thana; 1 Asifabad, Hyderabad; 1 Laisingah, Cachar, 1 *Prome, Burma.*

The upper parts are darker than in *pallidogularis.* Vaurie (1959, p. 384) refers to *przevalskii* of Tagarnov (Zagan-Bulyk, Ala Shan Range) being recorded in winter from northern Bengal and northern Bihar, but this is synonymised with *saturatior* in Ripley's SYNOPSIS (1982). The male from Asifabad, Hyderabad dt. 12 December 1931 is one of the first *saturatior* recorded from India, but it has a 79 mm wing and an attenuated bill, the latter being a character of *abbotti* and the wing being too large for both *abbotti* and *saturatior.*

Measurements on p. 118-19.

EL **Erithacus svecicus magna** (Zarudny and Loudon) (Bidesar, Arabistan)

6: 3 ♂♂ 1 ♀♀ 2 o?

1 *Lake Akkarkuf,* near *Baghdad,* 1 *Nahr Umar, left bank of Tigris,* 1 *Feluja,* 2 *Basra,* 1 *Shaiba, Mesopotamia.*

The large wing 78-81 mm in both the sexes together with the absence of the black border to the red of the breast appear distinctive. The jugular spot is absent in all except for a small white one in ♂ No. 3165 dated 28 March 1917 from Feluga. The plastron is of varying shades of pale blue.

Measurements on p. 118-19.

EL **Erithacus svecicus volgae** Kleinschmidt (Sarpa, lower Volga)

5: 2 ♂♂ 2 ♀♀ 1 o?

2 *Ctesiphon, Baghdad,* 1 *Amara,* 1 *Sheikh Saud,* 1 *Fao, Mesopotamia.*

These are slightly smaller than nominate *svecicus* (and *magna*) obtained in Mesopotamia over the same period.

Measurements on p. 118-19.

1647 **Erithacus pectoralis pectoralis** (Gould) (Western Himalayas) West Himalayan Rubythroat 2:92

12: 10 ♂♂ (1 juv.) 2 ♀♀

1 Chitral, N.W.F.P., 1 Fagu, Keonthal State; 1 Above Chini, Bashchi State, Punjab; 1 Liddar Valley, 1 Sonamarg, 1 near Suru, Ladakh, 2 Kashmir; 2 Badrinath, Garhwal, 2 Ranibagh, Kumaon.

Some of the males have paler and an almost pink chin and throat.

Measurements on p. 119.

1648 **Erithacus pectoralis confusus** (Hartert) (Sikkim) Eastern Rubythroat 2: 93

nil.

1649 **Erithacus pectoralis tschebaiewi** (Przevalski) (Kansu) Tibetan Rubythroat 2:94

8: 7 ♂♂ (1 by pl.) 1 ♀

1 Hasimara; 2 Bhutan, Duars; 1 Goalpara, 1 Lakhimpur, 1 Sadiya; 1 Miao, Tirap Div., Arunachal Pradesh; 1 no data*.

* This specimen bore No. 3204 and the

same data as on a ♂ of the nominate race from Suru, Ladakh. It has been renumbered (26533) and left with no data.

The red of the chin and throat varies in intensity as in the nominate form, but the white malar streak is distinctive.

Measurements on p. 119.

1650 (1651) **Erithacus brunneus** (Hodgson) (Nepal) Indian Blue Chat 2: 14

26: 16 ♂♂ (1 juv.) 9 ♀♀ 1 o?

1 Nathia Gali, N.W.F.P.; 1 Kufri, Patiala State; 1 Fagu, Keonthal State, 3 Koti State, 3 Simla; 1 Garhwal, U.P.; 2 Mahabaleshwar, Satara, 1 Sholapur; 1 Munnar, 1 Ponmudi, Kerala; 1 Longwood Shola, Kotagiri; 3 Pt. Calimere, Tamil Nadu; 1 R. V. Nagar, 1 Sankrametta, Vizagapatnam dist., 2 Jeypore Agency; 1 Shillong, Assam; 2 Mt. *Victoria, Pakokku Hill Tracts, Burma.*

Sp. No. 2187 Mt. Victoria has a small (69 mm) wing and tail (36 mm) but there is no evidence of a moult in progress.

Measurements on p. 119.

1652 **Erithacus pectardens** (David) (Moupin = Paohing, Eastern Sikang) Firethroat

nil.

1653 **Erithacus cyane cyane** (Pallas) (Dauria, Southeastern Transbaikalia) Siberian Blue Chat 2: 12

3: 2♂♂ 1 ♀

1 Chiria Tapoo, S. Andamans; 2 *Peking, China.*

The female from Chiria Tapoo has the wing as large as in the males, and the tails are shorter than in Dementiev (quoted in INDIAN HANDBOOK).

Measurements on p. 119.

1654 **Erithacus cyanurus pallidior** (Baker) (Simla) Kashmir Redflanked Bush Robin 2: 101

26: 15 ♂♂ (2 in first year pl.) 7 ♀♀ 4 o?

2 Gora Galli, Murree Hills, Rawalpindi; 2 Gilgit, 1 Miniming, Gilgit Road, 1 Baltal, 1 Dossoo, 1 Gulmarg, 1 Liddar Valley, 1 Kashmir; 1 Dharamsala, 9 Simla, 1 Chakrata, Dehra Dun, 2 Pindari, 2 Kumaon, 1 Yoshinath, Garhwal.

See remarks under 1655.

Measurements on p. 120.

1655 **Erithacus cyanurus rufilatus** (Hodgson) (Central & northern regions of hills, Nepal) Eastern Redflanked Bush Robin 2: 99

17: 10 ♂♂ (5 in first year pl.) 6 ♀♀ 1 o?

3 Rinchingpong, West Sikkim; 1 Batase, 2 Shamgong, 1 Tama, Central 1 Rongtong, 2 Gomchu, 1 Narphong, 3 Wamrong, East Bhutan; 1 Endoling, Dibang Valley, Mishmi Hills, 1 Bomdila, A.P., 1 Kargpokpi, Manipur.

There is appreciable variation in the intensity of the blue in the male in adult plumage and the two races are not very distinct, a statement made earlier by Meinertzhagen (*Ibis* 1927, p. 588) and others.

The adult males are larger than the first year birds which are known to breed. Sp. No. 25343 a ♂ from Tama, Central Bhutan has a 90 mm wing which is exceptionally large contra 81-86 av. 83.7 in the remaining four. Another ♂ No. 25342 from Gomchu c. 7500′ E. Bhutan has the brown upperparts very pale and washed with blue, very different from the others available. Its measurements are included with those of 1st year birds.

Measurements on p. 120.

1656 **Erithacus cyanurus cyanurus** (Pallas) (Yenesei) Japanese Blue Chat 2: 98

9: 5 ♂♂ 4 ♀♀

9 *Temple of Heaven, Peking, China.*

The males have a very distinct white eyebrow, but the specimens go back to 1901 and being in very poor and fragile condition, this character is not visible in the females. Both sexes have their tails shorter than in the other races.

Measurements on p. 120.

1657 **Erithacus chrysaeus whistleri** (Ticehurst) (Simla) Western Golden Bush Robin 2: 97

5: 2 ♂♂ (1 by pl.) 3 ♀♀

1 Dharamsala, Punjab; 1 Bhajji State, 1 Tara Devi, Patiala; 1 Flaghill, Mussoorie; 1 Bhim Tal.

These skins are older than those under 1658 below and the difference in colour may to some extent be due to this factor.

Measurements on p. 120.

1658 **Erithacus chrysaeus chrysaeus** (Hodgson) (Nepal) Eastern Golden Bush Robin 2: 95

11: 5 ♂♂ 4 ♀♀ 2 o?

1 Chapcha, 1 Gedu, West; 2 Tama, Central; 1 Narphong, 2 Wamrong, 2 Khosela, 1 Bumthang, East Bhutan; 1 Kohima, Naga Hills.

Measurements on p. 120.

1659 **Erithacus indicus indicus** (Vieillot) (Darjeeling) Whitebrowed Bush Robin 2: 102

nil.

1660 **Erithacus hyperythrus** (Blyth) (Darjeeling) Rufousbellied Bush Robin

5: 3 ♂♂ (1 by pl.) 2 ♀♀ (1 by pl.)

1 Bumthang, 10850′, Central; 1 Gomchu, 1 Wamrong, E. Bhutan; 1 Bipani, 1 Ratane, Dibang Valley, Mishimi Hills, Arunachal Pradesh.

One female No. 25336 was registered under *E. cyanurus.*

Measurements on p. 121.

EL **Erithacus rubecula hyrcanus** Blanford (Ghilan) North Persian Robin

6: 1 ♂ 5 o?

1 *Baghdad,* 1 *Sheikh Saud,* 1 *Kurna,* 2 *Hawi Plain, Samara, Mesopotamia;* 1 *Abid, S. Persia.*

These and the next form are marked *hyrcanus* and *caucasicus* by Ticehurst (?) and are grouped accordingly though I cannot see any difference.

Measurements on p. 121.

EL **Erithacus rubecula caucasicus** (Buturlin (Caucasus) Caucasian Robin

2: 1 ♂ 1 o?

1 *Dialia, Baghdad,* 1 *Shat-el-Adhaim, left bank of R. Tigris, Mesopotamia.*

See remarks under last form above.

Measurements on p. 121.

EL **Luscinia luscinia** (Linnaeus) (Sweden) The Thrush Nightingale

4: 1 ♀ 3 o?

1 *Shaiba,* 1 *Residency, Baghdad,* 2 *Feluja, R. Euphrates, Mesopotamia.*

Though correctly identified by Ticehurst *et al.* both on the labels and in Birds of Mesopotamia (1922, *JBNHS* 28 p. 406) these were mixed up with *Luscinia megarhynchos* in the register. They can be separated by the tiny first primary, the emargination on the outer edge being restricted to the third primary, and the broad band across the breast.

Measurements on p. 121.

1661 **Copsychus saularis saularis** (Linné) (Bengal) Indian Magpie Robin 2: 113

59 (including 8 from Burma)

(a) 51: 31 ♂♂ 17 ♀♀ (2 juv.) 3 o?

1 Patiala, 1 Bhagat State 4000′, 1 Simla Hills; 1 Mussoorie, 1 Garhwal, 2 Almora; 2 Ambala, 3 Meerut, 1 Delhi; 1 Bharatpur; 1 Dabka, Baroda; 1 Kodinar, S. Kathiawar, 1 Jamnagar (?); 1 Goregaon. 1 Santa Cruz, 1 Pali Hill, Bombay; 1 Satara, 1 Ratnagiri; 1 Chitteri Range, 1 Shevaroy Hills, Salem dist.; 1 Palkonda Hills; 1 Seshachalam Hills, S. Cuddappa; 2 Nallamalai Range, S. Kurnool; 1 Godavari delta; 3 Sankrametta, 1 Jaypore Agency, Vizagapatnam dist.; 1 Darba, Bastar, 2 Bhanupratappur, Kanker, C. P., 1 Tikarpara, Angul dist., Orissa; 1 Banhar, Darbhanga dist., Bihar; 1 Nawacot, Nepal; 1 Rongtong, 1 Wamrong, E. Bhutan, 1 Mangdeshu, 1 Jalpaiguri, 1 Singtam, Teesta Valley, W. Bengal; 1 Dibrugarh, 1 Sadiya 3 Assam; 1 Haflang, North, 1 Cachar.

The amount of black in the 4th rectrix varies and cannot be localized except in the 3 from S. Andaman. Species No. 1663 *erimelas* of Oberholser (Type Tenasserim) which was said in INDIAN HANDBOOK to occur in north-east India has been merged with *saularis* in SYNOPSIS 2nd ed. (1982) and there is no consistant difference in the amount of black and white in the tail.

In juveniles, in addition to the spots on the breast, the rufous edges to the primaries form a distinct patch at the end of the closed wing, as is noted for *C. m. malabaricus* (INDIAN HANDBOOK, 8 p. 245).

(b) 8: 5 ♂♂ 3 ♀♀

3 *Upper Burma*; 1 *Thayetmyo*; 1 *Sandoway*, 3 *Prome*, *Burma*.

The single male from Sandoway has the 4th rectrix, all black with a small white tip as in those from south Andaman (q.v.). But the others are otherwise inseparable from nominate *saularis*.

Measurements on p. 121.

1662 **Copsychus saularis ceylonensis** Sclater (Ceylon) Ceylon Magpie Robin 2: 115

12: 7 ♂♂ 5 ♀♀

1 Kumta, 1 Karwar, N. Kanara; 1 Murgimatta, 1 Lingandhalli, 1 Taluppa, 1 Sagar, Mysore; 1 Wynaad; 1 Gudalur, Nilgiris; 1 Palni Foothills, 1 Vangayam Palnis (?); 1 Mercara, Coorg; 1 Maraiyur, Travancore.

The males do not show the greenish iridescence (*contra* purplish) as required in the key in INDIAN HANDBOOK (8, p. 239) but not referred to later under Museum Diagnosis. Dr. B. Biswas tells me that two males from Kerala at the Zoological Survey are similar and do not show a greenish tinge. In the absence of any specimens from Sri Lanka these birds are listed separately from nominate *saularis* mainly on the strength of the statements of earlier workers, and the fact that the females have darker breasts.

Measurements on p. 121.

1663 **Copsychus saularis erimelas** Oberholser (Tenasserim) Indian Magpie Robin

This has been synonymised with *saularis* in SYNOPSIS 1982, p. 455 and there is no consistent difference in the amount of black and white in their tails.

1664 **Copsychus saularis andamanensis** Hume (Andaman Island) Andaman Magpie Robin 2: 116

4: 3 ♂♂ 1 ♀

1 Bakultala, Middle, 1 Port Blair, 2 Manarghat, S. Andaman.

The bills are heavier than indicated by the measurements. In both sexes the white of the underparts is edged with grey. In all 3 from South Andaman the 4th rectrix is completely black on both the inner and outer webs except for a small white edge at the tip, a character shared with only one male No. 3336 from Sandoway dist., Burma. The single male from mid-Andamans has the heavy bill and grey edges to the white of the underparts but the 4th rectrix is largely white with black edges to both sides, a character often found in *saularis*.

Measurements on p. 121.

1665 **Copsychus malabaricus malabaricus** (Scopoli) (Mahe, Malabar) Malabar Shama 2: 118

12: 10 ♂♂ (1 Juv.) 2 ♀♀

1 Waghai, Surat Dangs; 1* Hills near Thana, Bombay; 1 Koina River Project, Satara Dist.; 1 Sawantwadi, Maharashtra; 1 Canacona, Goa; 3 N. Kanara; 1 Murgimatta, Sagar, Shimoga dist., Mysore; 3 Mudamallar; Nallacotta, Nilgiri Hills.

See remarks under 1667 *C. m. indicus*

Measurements on p. 122.

1666 **Copsychus malabaricus leggei** (Whistler) (Uragaha, Ceylon) Ceylon Shama

nil.

1667 **Copsychus malabaricus indicus** (Baker) (Bhutan Duars) Indian Shama 2: 118

42: 27 ♂♂ 15 ♀♀

2 Kurumbapatti; 1 Chitteri Range, Salem dist., 1 Palkonda Hills, South Cuddappa; 1 Anantgiri, Vizagapatnam Hills; 2 Lohattar, Kanker; 4 Antagarh, 1 Chota Dongar, Bastar, M.P.; 2 Berbera, Puri, 1 Tikerpara, Angul, 2 Kuldiha, Nilgiri, 1 Badrama, Bamra, 2 Koira, 1 Toda, Bonai, 2 Gurguria, 1 Simlipal Hills, Mayur Bhanj, 1 Orissa;

1 Sarda(r) River, Haripur, 1 Dehra Dun,, U.P.; 1 Pershoke, Sikkim; 1 Longview Tea Estate, Darjeeling; 2 Samchi, West, 3 Gaylegphug, Central Bhutan; 1 Margherita, Assam; 1 Haishanbao, 1 North Cachar; 1 *Upper Burma*, 1 *Nyannggyo*, *Myingyan dt.*, 1 *Thome*, *Prome dist.*, 1 *Sandoway*, *Burma*; 1 cage bird (Origin?)

Stuart Baker when describing *indica* from Bhutan Duars compared it with *macrurus* from Malaya and said it was found over the whole of India as far south as Sri Lanka and the north of Tenasserim in Burma. Later, Whistler (*JBNHS* 36, p. 74) changed the name to *malabaricus* and identified birds from Kurumbapatti etc. in the Eastern Ghats as of this form. Ripley (*JBNHS* 49, p. 398) drew attention to northern birds having shorter tails and used the name *indicus* for birds south to the Cauvery river. The key in INDIAN HANDBOOK (8, p. 244) separates them by "tail averaging longer" and "shorter" but due to the overlap in sizes this appeared to be unworkable. However, if it is accepted that winter males in both areas (or subspecies) have their tails 30 mm shorter than in summer, the average difference of about 10 mm in tail length is consistent between the western *malabaricus* and *indicus* north of the Cauvery. There is an insufficient number of females to offer any comparative remarks.

Sp. No. 16624 from Gurguria, Simlipal Hills, has a female plumage and measurements but is marked ♂, presumably in error. Another ♀ No. 16623 from the same place has the chestnut of the underparts darker than in the others. Female No. 3386 from Sardar (Sarda) river, Haripur U.P. collected on 9 February 1924 is a much paler brown above and strikingly different. The females have a varying extent of grey on the chin.

The single juvenile (*malabaricus*) has rufous edges to the flight feathers as in juvenile *saularis*.

The 7 Andaman birds have dark edges to the flight feathers but in both *malabaricus* and *indicus* the majority of winter birds of both sexes have them paler, but not rufous.

Measurements on p. 122.

1668 **Copsychus malabaricus albiventris** (Blyth) (Andamans) Andaman Shama 2: 119

7: 4 ♂♂ 3 ♀♀ (1 juv.)

1 Calicut, 4 Chiria Tapoo, 2 Pyinmanala, S. Andaman.

See remarks under 1667.

Measurements on p. 122.

1669 **Phoenicurus erythronotus** (Eversmann) (Altai) Eversmann's Redstart 2: 73

26: 18 ♂♂ (7 by plumage) 8 ♀♀

1 *Piri Bana*, 9 m. south of, 3 *Shiraz, Iran*; 1 Drosh, 1 Ghairat, 2 Nagar, 1 Ayun, 1 Chitral, 1 Risalpur, 1 Rawalpindi, 1 Kohat, N.W.F.P.; 1 Wana, Waziristan, 2 Chaman, 3 Quetta, Baluchistan; 1 Attock Fort, 2 Campbellpur, Punjab; 1 Keonthal, Simla Hills; 1 *Kaying Bashi*, 1 *Kashgar*, 1 *Keriya, Chinese Turkestan.*

The 4 from Shiraz, Iran (Feb./March) all in male plumage (though 2 are marked females) have paler gray heads than the other 15.

In INDIAN HANDBOOK (8, pp. 248-9) the key for the identification of the female requires a wing over 90 mm but the measurements which follow read 81-86 mm. All our measurements are also under 90 mm.

Measurements on p. 122.

1670 **Phoenicurus caeruleocephalus** (Vigors) Blueheaded Redstart 2: 104

29: 16 ♂♂ 13 ♀♀

1 Drosh, 9 Chitral; 1 Kurram Militia, Parachinar, N.W.F.P.; 1 Ghora Gali, Murree Hills, Rawalpindi, 1 Dalhousie, Gurudaspur, Punjab; 1 Chini, Bashahr, 1 Mashobia, 8 Simla, 2 Keonthal, 1 Taradevi, 1 Patiala; 1 Nila Valley, 1 Garhwal, U.P.

The head is hardly blue, but more greyish.

Measurements on p. 122.

Phoenicurus ochrurus

The specimens include several taken in Mesopotamia and Iran during and just after

the First World War and it is difficult to separate the three races *ochrurus, phoenicuroides* and *rufiventris* occurring in the area. They have however been marked when fresh by Ticehurst and others while working on the birds of Iraq, Iran and India, and the present grouping is to some extent guided by their findings. The discrepancies, if any, are referred to under each form.

EL **Phoenicurus ochrurus ochrurus** (Gmelin) (Mountains of North Persia) Black Redstart

11: 6 ♂♂ 5 ♀♀

1 *Mosul*, 1 *Sheik Saud*, 1 *Bait-al-Khalifa, N. of Samarra*; 5 *Hawi Plain, Samarra*, 1 *Kazimain, Baghdad, Mesopotamia*; 2 *Shustar, Persia.*

3 of the males Jan./Feb./March have chestnut underparts meeting the black breasts while the other three (Dec./Jan./Feb.) lack the chestnut below, only one (No. 3025 Feb.) having a rufous crissum. All have been marked nominate *ochrurus* by Ticehurst (?) and 5 are so listed in 'Birds of Mesopotamia' *JBNHS* 28, p. 404-5. With the evidence available they are now so accepted.

Measurements on p. 123.

1671 **Phoenicurus ochrurus phoenicuroides** (Moore) (Shikahpur, Sind) Kashmir Black Redstart 2: 76

70: 45 ♂♂ (11* imm. plumage) 21 ♀♀ 4 o?

1 *Zohab*, 1 *Nisiriyeh*; 3 *Mishun, Persian Gulf*, 1* *Tamb Island, Mesopotamia*; 1 *Peri Banu*, 9 *m. s. of Shiraz*; 3 *Shiraz*; 1* *Koh-i-Sifta*, 17*m. n.e.* of *Pahran*; 1* *Pahran*, 17*m. e.* of *Bampur, Persian Baluchistan*; 1 Chaman, 1* Bostan Terek, Pishin dist., Quetta; 3 Harboi, 1 Panjgur, Kalat, Baluchistan; 1 Wana, N.W.F.P., 5 Chitral, 1 nr. Campbellpur, 1 Rawalpindi; 1 Shikohpur, Jullundur, 3 Ambala, 1 Jagadri, 1* Punjab; 1 Kiber, Spiti, Kangra, 1 Simla, 1 Koti, Bhagat State; 1 Kashmir; 1 Tankse, 1 Karzok, 1 Tso Morari, 1 Shyok Valley, 1 Matyan, Ladak; 1 *Rham, Tibet*, 2* *Kying Bashi, Chinese Turkestan*, 2 Bhung, 1 Chachran, 1* Bahawalpur Town Environs, 1 Manthar, Cholistan, 1 Bahawalpur State; 1 Bulandshar, 3 Meerut, 4** Delhi; 1 Kanpur, 1* Jalar, Jodhpur, Rajputana; 1 Sukkur, Sind; 1 Chobari, Bachau dist., 2* Bhujia Fort, 1 Devisar Tank, Bhuj Environs, 2* Bhuj, 1 Kuar Bet, Kutch; 1 Patan, 1 Vagjipur, Mehsana, Gujerat.

The 30 adult males have greyer heads but are no larger than the immature (first year) males*, all the 45 males together having their wings 77-87 av. 82.2 as compared to 29 *rufiventris* 84-93, av. 88.5. The females averaging 81.4 and 84, i.e. 85% and 5% smaller respectively. The females of *rufiventris* are slightly darker both above and below but there appears to be no certain means of separating the females of the two races. In *phoenicuroides* the females number 47% of the whole population as against only 20% in *rufiventris*; it is probable that some of the latter are included with the former.

Measurements on p. 123.

1672 **Phoenicurus ochruros rufiventris** (Vieillot) (Gyantse) Eastern Black Redstart 2: 77

37: 29 ♂♂ 6 ♀♀ 2 o?

1 Khardong, Ladakh; 1 Shikohpur, Jullundur, 2 Ambala, Punjab; 2 Delhi; 3 Bharatpur, 1 Maval, nr. Abu Road, Rajputana; 1 Changalra, Bhuj, Kutch, 1 Dwarka, Okhamandal, 1 Ghatwad, S. Kathiawar, 1 Bodeli, Baroda, 1 Mahal, Surat Dangs; 1 Gwalior; 1 Saugar, 1 Sanchi, Bhopal; 1 Raipur, Melghat, Berar; 2 Mehda, 1 Satara; 1 S. Konkan; 1 Seshachalam Hills, Cuddapah dt., 1 Bhopalpatnam, 1 Geedam, Bastar; 1 Nuhar, Madhubani, 2 Baghowni, Bihar, 2 Goalpara, Assam; 1 Kalianpur, Cawnpur, 1 Ganga Canal, Meerut, 1 Niti, Garhwal, U.P.; 1 E. Everest, Nepal, 1 *Nyenyam*, 1 *Jungla, S. Tibet.*

See remarks under 1671. The males in immature plumage cannot be separated into the two races accepted in India and none of the 11 birds in this plumage have been obtained east of Delhi and Meerut where the two forms overlap.

If all birds in this plumage are left as *phoenicuroides* as has been done, *rufiventris* does not acquire this plumage? As this is unlikely (?) it must be admitted that some of them are *rufiventris* and birds in this plumage

cannot, until this matter is clarified, be accepted as distributional records of either race.

Measurements on p. 123.

1673 **Phoenicurus phoenicurus phoenicurus** (L.) (Sweden) The Whitefronted Redstart Not in Fauna

21: 16 ♂♂ 5 ♀♀

2 *Niton, I. of Wight, England*; 1 *Mosul*, 1 *Sulaimaniya*; 1 *Kazimain*, 3 *Baghdad*; 1 *Nahr-Umar, left bank of R. Tigris*, 1 *Basra*, 2 *Felujah*, 3 *Shatt-el Adhaim*, 2 *Sheikh Saud, Mesopotamia*; 1 *Fao*, 1 *Persian Gulf*; 1 Chitral, N.W.F.P.

This species is separated from *Phoenicurus ochruros* by the absence of emargination on the outer web of the 6th primary, and the white on the forehead in summer. 6 males with white on the forehead are dated 5th April to 15th May, the last being from Chitral and one of the few obtained in Indian limits.

Measurements on p. 123.

EL **Phoenicurus phoenicurus samamisicus** (Hablitz) (Gilan, N. Persia) Persian Redstart

5: all males (1 by plumage)

2 *Felujah*, 1 *Zubier*, 1 *Shaik Saud*, 1 *Hawi Plain, Samarra, Mesopotamia*.

The birds are marked *mesoleuca* (Hemprich & Ehrenberg, Jidda, Arabia) synonymised with this form by Meinertzhagen BIRDS OF ARABIA (1954). Meinertzhagen also states that the females cannot be told with certainty from those of the nominate race and it is quite possible that some are included with the females from Mesopotamia under 1673.

Measurements on p. 123.

1674 **Phoenicurus hodgsoni** (Moore) (Bootan) Hodgson's Redstart 2: 74

14: 7 ♂♂ 7 ♀♀

1 *Kharta, S. Tibet*; 1 Godaveri Nepal; 1 Rangpo, Sikkim; 1 Chapcha, 2 Samchi, West, 1 Tama, Central, 1 Rongtong, 1 Tashigong, East, 1 Gyetsa, Bhutan; 2 Bhutan Duars, Bengal; 2 Dibrugarh, Assam.

Though the measurements were rechecked, the females have their tarsi fractionally larger than the males.

Measurements on p. 123.

1675 **Phoenicurus frontalis** (Vigors) Bluefronted Redstart 2: 69

36: 24 ♂♂ 8 ♀♀ 4 o? (1 fledgling)

1 Lidar Valley, 2 Kaishoo Nallah, 1 Chichoti, Kishtwar, 1 Murree, 2 Dharamsala, 6 Simla, 1 Fagu, Keonthal State, 2 Mornala, 1 Kumaon, 1 Himalayas; 2 Chemgthang, North, 2 Rinchingpong, West, 1 Lachen, Sikkim; 1 Chima kothi, 1 Honka, West, 1 near Dochu La, West, 1 Tama, 1 Shamgong, Central, 1* Gomchu, 1* Rongtong, 4** Narphong, East Bhutan, 1 Mokokching, Naga Hills, 1 Rotung, Abor Country, Assam.

* With dark breasts.

Some have more blue on the forehead, breast and chin than in others. The four birds in first year or female plumage (1 ♂ 3 ♀♀) from Eastern Bhutan (Feb./March 1966) have a much darker brownish wash both on the under and upperparts than in five others from west Bhutan (Nov. 1968) and further west, including Sikkim. The 2 adult males from East Bhutan show no difference from others further west.

Measurements on p. 123.

1676 **Phoenicurus schisticeps** (Gray) (Nepal) Whitethroated Redstart 2: 70

4: 1 ♂ (by plumage) 3 ♀♀

3 Lachung, North Sikkim; 1 Rongtong, East Bhutan.

Measurements on p. 124.

1677 **Phoenicurus auroreus leucopterus** (Blyth) (Malay Peninsula) Daurian Redstart 2: 71

13: 5 ♂♂ (2 by pl.) 7 ♀♀ 1 o?

1 *Triphi*, 1 *Tunbe, Lower Tsang Valley, S. Tibet*; 3 Dibrugarh, 1 Sadiya, 1 Tezu, Lohit Valley, Assam; 1 Abor Country, Upper Assam; 1 *Monywa, Lr. Chindwin*, 1 *Loi-Long, N. Shan States, Burma*; 3 *Temple of Heaven, Peking, China*.

The two females from Triphi and Tunbe, Lower Tsang Valley, S. Tibet obtained by Capt. F. M. Bailey in July and August 1913

lack the rufous on the underparts and the labels were marked "for identification of eggs". As they appeared to be a different species they were sent to the British Museum (N.H.) at Tring and Mr. Colston says they are of the same but in badly worn plumage.

Measurements on p. 124.

1678 **Phoenicurus erythrogaster grandis** (Gould) (Afghanistan & Tibet) Güldenstadt's Redstart 2: 78

17: 11 ♂♂ (1 first year, 1 by pl.) 6 ♀♀

6 Chitral Drosh, N.W.F.P., 1 Sangpoche 15800′ Shaksgam, Kashmir; 1 Karzok, Tsho Marari, 1 Madhopur, Punjab; 1 *E. Everest, Tibet*; 1 Kashgar, Chinese Turkestan; 3 Gyantse, 1 Ugu Nallah, Ladak; 2 Lachung, N. Sikkim.

Two males from E. Everest and Gyantse, and a female from the last place have their wings 113, 110 and 108 mm which are the largest in both sexes. The two females from Gyantse have both their upper and underparts tinged with rufous, separating them from the other females. A larger series is required to warrant a separation. No. 3075 from Chitral marked female has a white patch on the wing, a character of a juvenile male referred to in BIRDS OF SOVIET UNION 6, p. 657, but not in Indian literature.

Measurements on p. 124.

1679 **Rhyacornis fuliginosus fuliginosus** (Vigors) (Himalayas, restricted to Simla Almora Area) Plumbeus Redstart 2: 81

33: 21 ♂♂ (1 juv.) 8 ♀♀ 4 o? (1 juv.)

5 Chitral Drosh; N.W.F.P.; 1 Yusmarg, 2 Kashmir; 1 Pulbahl, 7000′, 9 Simla, 1 Koti State, 1 Simla Hills; 2 Gupta Kashi, 2 Lohba, Garhwal; 1 Pindar Valley, U.P.; 1 Rangpo, Sikkim; 1 Samchi, 1 Honka, West, 1 Bumthang, Central, 2 Gomchu, East Bhutan; 1 N. Cachar, 1 Abor Country, Assam.

♂ No. 21062 collected by Salim Ali at Rangpo, Sikkim on 2/12/52 has the underparts diagonally separated into two colors on — one (smaller) like a female and the other black like an adult male. The label bears a note by SA "only one pigmented testes on side of adult plumage".

Measurements on p. 124.

EL **Irania gutturalis** Guerin — (Menevilte Abyssinia) Persian Robin

6: 2 ♂♂ 3 ♀♀ 1 o?

1 *Sheik Saud*, 1 *Felujah, R. Euphrates*, 1 *R. Tanhar*, 1 *Baghdad*, 1 *Basra, Mesopotamia*; 1 *Shiraz, Iran*.

Measurements on p. 124.

1680 **Hodgsonius phoenicuroides phoenicuroides** (Gray) Hodgson's Shortwing or White-bellied Redstart 2: 21

7: 4 ♂♂ 1 ♀ 2 o? (1 juvenile*)

1 Gulmarg, 3 Liddar Valley, Kashmir; 2* Narkand 9000′, Kumarsian State, Simla Hills, 1 Samchi, West Bhutan.

Only one male (No. 16360) from Narkand shot on 18th July had enlarged testes and is in full breeding plumage. Another (No. 2202 in ♀ or juvenile plumage) and d/20 June is marked "Breeding. Shot at nest".

Measurements on p. 124.

1681 **Cinclidium leucurum** (Hodgson) (Nepal) Whitetailed Blue Robin 2: 106

26: 17 ♂♂ (2 by pl.) 9 ♀♀ (1 by pl.)

1 Gangtok, Sikkim; 1 Hazimara Tea Estate, Darjeeling, Bengal; 1 Honka, 1 Samchi, 1 Phuntsholing, W. Bhutan; 3 Margherita, Upper Assam; 1 Shillong, 2 Dening, Lohit Valley, N. E. Assam, 4 Miao, 1 Tirap, 1 Firm Base, 3 Arunachal Pradesh; 2 *Gora*, 2 *Hai Bum, Upper Burma*; 1 *Mt. Victoria*, 1 *Nyamgyo, Prome, Burma*.

♀ Nos. 26064 and 26332 from Arunachal Pradesh differ from the others in the heavy markings on the chin.

Measurements on p. 124.

1682 **Cinclidium frontale frontale** Blyth (Sikkim) Bluefronted Robin 2: 107

nil.

1683 **Grandala coelicolar** Hodgson (Nepal) Grandala 2: 89

11: 8 ♂♂ (1 juv.) 3 ♀♀ (1 juv.)
1 Nila Valley, 2 Garhwal; 3 Thangu, Sikkim; 4 Lachung, 1 Native Sikkim.

The immature male is like the female but has the streaks larger.

Measurements on p. 125.

1684 **Enicurus scouleri scouleri** Vigors (Himalayas-Simla) Little Forktail 2: 65
25: 7 ♂♂ 13 ♀♀ 5 o? (1 juv.*)
3 Chitral, N.W.F.P.; 1 Chichoti, Kishtwar, 1 Kashmir; 1 Keonthal State; 1 Koti State, 1 Wanghu Bridge, 3 Simla, 3 Simla Hills; 3 Rambara, Kedarnath, 1 Pindari, Garhwal; 1 Hetwada, Nepal; 1 Kurseong, Darjeeling; 1 Honka, West, 1 Tongsa, Central, 1 Gomchu, East, 1 Khosela, 1 Bhutan.

The unsexed juvenile from Wanghu Bridge (Jones's Collection) has a spotted breast.

Measurements on p. 125.

1685 **Enicurus immaculatus** (Hodgson) (Nepal) Blackbacked Forktail 2: 61
11: 9 ♂♂ 2 ♀♀
2 Kalijhora, Tista Valley, Sikkim; 1 Lakhimpur, 2 North Cachar, 1 Larsingha T. E., Cachar; 1 Changchangpani, 1 S. Sylhet, Assam; 2 *Thayetmyo*, 1 *Nyaunggyo, Burma.*

Measurements on p. 125.

1686 **Enicurus schistaceus** (Hodgson) (Nepal) Slaty backed Forktail 2: 59
17: 11 ♂♂ 4 ♀♀ 2 o?

1 Kumaon, U.P.; 2 Rongni R., Martam, 1 Seooke, 1 Singtam, Teesta Valley, Sikkim; 1 Samchi, West, 1 Mangdechu, Central, 1 Gomchu, 1 Deothang, East Bhutan; 1 Arunachal Pradesh, 1 Dening, Lohit Valley, N.E., 4 Margherita, Upper Assam, 1 Jatinga Valley, 1 North Cachar.

Measurements on p. 125.

1687 **Enicurus leschenaulti indicus** Hartert (Margherita, Upper Assam) 2: 62
3: 2 ♂♂ 1 ♀
2 Margherita; 1 Mishing, Abor Country, Assam.

The wing of single female is much smaller (104 mm.) than the two males (114, 119).

Measurements on p. 125.

1688 **Enicurus maculatus maculatus** Vigors (Simla) Western Spotted Forktail 2: 57
26: 12 ♂♂ 10 ♀♀ (1 juv.) 4 o? (3 juv.)
2 Chitral, N.W.F.P.; 2 Galhar, Kishtwar, 1 Doosoo, 1 Banihal Village, Jammu side of tunnel, Kashmir; 3 Summer Hill, 1 Patiala State, 3 Simla; 1 Magra, Mussoorie; 2 Karchana, 1 Pithorgarh, Garhwal; 1 Bans, Almora, 3 Dakuri, Kumaon, U.P.; 1 Bans Behari, 1 Chalna Khel, 1 Godavari, 1 Kaikani, Nepal; 1 Cherra, Cherrapunji, Shillong, Khasi and Jaintia Hills.

The 4 juveniles are smoky brown above and below, with traces of streaks on the breast and with white forehead or spots above. The last two characters are not mentioned, in the FAUNA or in HANDBOOK.

The females have their tails 109-146 (average 133), longer than in the males 102-148 (avg. 122), a character not noticed earlier.

Measurements on p. 125.

1689 **Enicurus maculatus guttatus** Gould (Sikkim, Darjeeling) Eastern Spotted Forktail 2: 58
5: 2 ♂♂ 1 ♀♀ 2 o?
1 Gedu, 1 Chimakothi; West, 1 Batase, Central, 1 Rongtong, East Bhutan; 1 *Loi Lam, North Shan States, Burma.*

Neither of the two keys to subspecies separating this race from the last in (1) FAUNA by large and lunate white spots on the back (contra small and round spots) nor in (2) HANDBOOK requiring black breast feathers with white tips (contra without white tips) are consistent. The eastern birds listed here under 1689 do appear to have a straight white dividing line between the black and white on the breast but closer examination shows a straight white tip to the breast feathers which is not easily visible.

Measurements on p. 125.

1690 **Cochoa purpurea** Hodgson (Nepal) Purple Cochoa 2: 184

4: 3 ♂♂ 1 ♀

1 Mussoorie, 1 Naini Tal, U.P.; 1 Sipuri, Nepal; 1 Gedu, West Bhutan.

The female from Sipuri, Nepal was marked and registered as *C. viridis* of which we have no specimen.

Measurements on p. 125.

1691 **Cochoa viridis** Hodgson (Nepal) Green Cochoa 2: 185

nil.

1636 **Brachypterix hyperythra**

	Wing	*Bill*	*Tarsus*	*Tail*
o? (1)	66	12.5	26.9	46
	(Baker ♂♂ 63-64	*c.* 11	28-29	38-45)

1637-38 **Brachypterix major** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1637 *major*	nil			
1638 *albiventris* (1)	80	14.1	26.5	63
	(Baker ♂♀ 78-83	15	29	63-65)
♀♀				
1637 *major* (1)	80	14.6	26.5	58
	(Baker ♂♀ 78-83	16	29	59-65)
1638 *albiventris* (1)	78	14.4	26	60
	(Baker ♂♀ 73-78	15	29	63-65)

1639 **Brachypterix leucophrys nipalensis**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (2)	61, 64	12, 12.2	24.3, 25.2	33, 35
♀♀ (6)	61-64 av. 62.2	12.7-13.6 av. 13.2	23-26.2 av. 24.5	32-36 av. 33.4
	(Baker ♂♀ 58-64,	11.5-13	*c.* 26	27-32)
o? (1)	60	12.7	23.3	32

1640 **Brachypterix montana cruralis**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (6)	66-72 av. 68.8	11.6-12.6 av. 12	28.5-32 av. 30.5	41-47 av. 44.7
	(IH 64-72	from skull 15-16	31-34	42-48)
♀♀ (5)	64-68 av. 65.8	12-13.3 av. 12.6	28-30.7 av. 29.3	39-46 av. 41.8
	(IH 64-68	from skull 15-16	29-31	43-47)

1641 **Erythropygia galactotes familiaris**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
a (7)	82-88 av. 84.7	13.2-15.5 av. 14.2	20.7-25.2 av. 23.6	61-67 av. 63.8
b (5)	83-88 av. 86.2	12.4-15.4 av. 14.4	22-24 av. 22.9	59-68 av. 65.2
	(IH 85-90	from skull 16-18	24-27	61-67)
♀♀				
a (4)	81-86 av. 83.2	13.7-14.7 av. 14.2	22-23 av. 22.4	63-66 av. 64.5
b (1)	87	15.5	23.3	60
	(IH 85-87	from skull 15-16	24-25	63-66
o?				
a (6)	82-89 av. 85.5	14.4-15.6 av. 14.9	21.7-24.4 av. 23.2	64-71 av. 66
b (2)	86	14.9, 15	21.3, 23.9	64, 64

EL **Erythropygia galactotes syriacus**

	Wing	*Bill*	*Tarsus*	*Tail*
♂ (1)	86	14.9	21.7	71

EL **Erithacus megarhynchos africana**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (6)	85-89 av. 87	11.5-13.5 av. 12.3	22.6-25.3 av. 23.8	73-79 av. 75.5
	(B.H.B. 82-89			73-78)
♀♀ (2)	81, 88	12.3, 12.6	24, 25.3	71, 77
	(B.H.B. 78-84)			
o? (1)	89	—	26	76

1643 **Erithacus calliope**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (16)				
2 by plumage	73-82 av. 77.6	12.2-14.4 av. 13.2	25.2-29.4 av. 27.2	55-64 av. 58.5
♀♀ (4)	67, 71, 71, 77 av. 71.5	—, 12, 12, 12.7 av. 12.2	24.1, 24.7, 26.4, 26.5 av. 25.4	53, 55, 56, 58 av. 55.5
	(IH ♂♀ 71-80	from skull 15-18	26-31	58-61)
o? (2)	68, 78	11.8, 12.2	26.3, 26.5	54, 55

1644/46a & EL **Erithacus svecicus** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1644 *svecicus* (9)	72-80 av. 75.3	10.4-12.6 av. 11.5	23.1-27 av. 25.4	48-57 av. 52.3
	(IH 68-79 av. 72.8	11-12	—	55-58)
			(Dementiev)	
1645 *pallidogularis* (27)	68-77 av. 72.2	10.3-12.7 av. 11.4	23-27.7 av. 25.6	49-57 av. 53
	(IH 70-75	from skull 15-16	25-27	55-58)
1646 *abbotti* (2)	72, 72	11.7, 12.7	23.5, 25	55, 55
	(IH 71-72	from skull 16.7-17.5	—	56-57)
			(Richmond)	
1646a *saturatior* (7)	73-79 av. 75.5	10.1-12.6 av. 11.6	24-27.2 av. 25.3	52-59 av. 54.1
	(IH 69-76	from skull 15.5-17	—	—)
EL *magna* (3)	80, 80, 81	11.4, 12, 13.9	24.6, 25, 25.2	53, 55, 62
	(Ticehurst 80-83.5	—	—	60-63)
EL *volgae* (2)	72, 77	10.6, 13	23.6, 26.3	53, 55
	(Ticehurst 67-74)	—	—	—
♀♀				
1644 *svecicus* (1)	71	11.3	25.3	52
	(IH 64-73 av. 69.4	11-11.4	—	55-58)
			(Dementiev)	
1645 *pallidogularis* (13)	65-72 av. 69	10.2-12.3 av. 11.3	22.2-26.5 av. 24.6	49-55 av. 50.9
	(IH 70-74	from skull 15-16	—	—)
1646 *abbotti* (3)	69, 70, 74	11.5, 12.3, 13.6	22.9, 25.6, 26.5	53, 53, 54
	(IH ♂♀ 72-74	from skull 16.7-17.5 (Hartert)		

1644/46a & EL **Erithacus svecicus** subspp (contd.)

	Wing	Bill	Tarsus	Tail
1646a *saturatior* (1)	72	12.6	24	47
	(IH 71-73 (Kinnear)			
EL *magna* (1)	78	11.2	22.3	57
	(Ticehurst 78-79			
EL *volgae* (2)	70, 72	10.5, 11.1	23.9, 24.7	60-63)
	(Ticehurst 68-72)			51, 57

1647-9 **Erithacus pectoralis** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1647 *pectoralis* (10)	71-76 av. 74.3	11-14.3 av. 12.9	25-30 av. 26.2	54-62 av. 59.7
	(IH ♂♀ 68-78	from skull 18	*c.* 30	56-64)
				(Baker)
1649 *tschebaiewi* (7)	68-77 av. 74	11.3-13 av. 12.1	25.4-29.6 av. 27.6	53-63 av. 56.5
	(IH ♂♀ 73-81	from skull 15-17	33	58-66)
				(Baker)
♀♀				
1647 *pectoralis* (2)	71, 73	— 13	24.7, 26.8	53, 60
1649 *tschebaiewi* (1)	76	13.2	27.5	61

1650-51 **Erithacus brunneus**

	Wing	Bill	Tarsus	Tail
♂♂ (16)	72-81 av. 75	11-12.6 av. 11.8	21.5-26.5 av. 23.8	42-51 av. 47
	(IH 72-80	from skull 15-17	*c.* 26	45-53)
				(BB, HW, Koelz)
♀♀ (9)	70-78 av. 73.3	10.5-12.8 av. 11.9	22.4-25.2 av. 24	41-46 av. 43.5
	(IH 71-76	15-17	*c.* 26	44-50)
o? (1)	69	11.5	22.7	36

1653 **Erithacus cyane cyane**

	Wing	Bill	Tarsus	Tail
♂♂ (2)	73, 75	12.1, 12.5	23.4, 23.7	42, 45
	(IH 70-76	from skull 16-17	25	47-50)
				(Dementiev)
♀ (1)	75	11.5	24	41
	(IH 68-71	from skull 16-17	25	47-50)
				(Dementiev)

1654/6 **Erithacus cyanurus** subspp.

		Wing	Bill	Tarsus	Tail
♂♂ 1654 *pallidior* blue (13)		80-83 av. 81.5	9.5-11.7 av. 10.7	20.5-23.7 av. 22	55-56 av. 60.9
,, 1st year brown (2)		78, 79	9.4, 11.6	21.9, 22	57, 60
1655 *rufilatus* blue (5)		81-90 av. 85	10-12.2 av. 10.8	22-26.2 av. 24.4	59-67 av. 63.4
,, 1st year brown (5)		82-84 av. 82.4	9.2-10.5 av. 10	20.8-26 av. 23.9	58-63 av. 60.4
	(IH	74-80	from skull 13-15	24-27	65-70)
				(Mayr, B.B., NBK, Stres)	51-56 av. 54.2
1656 *cyanurus* (5)		77-82 av. 80	9-9.8 av. 9.5	20-21.3 av. 20.6	55-60)
	(IH	74-80	from skull *c.* 13		(Dementiev)
♀♀ *pallidior* (7)		71-80 av. 77.2	9.6-11.1 av. 10.1	20.5-22.2 av. 21.3	52-61 av. 55.4
rufilatus (6)		77-82 av. 79.8	9.7-11.3 av. 10.8	20.8-27.1 av. 23.4	54-55 av. 60
	(IH	76-83	from skull 13-16	24-27	56-65)
				(Mayr, B.B., NBK, Stres)	
♀ 1656 *cyanurus* (4)		74, 78, 79, 82	8.5, 8.9, 9.2, 10.6	19.7, 20.7	50, 51, 59 —
	(IH	70-78	from skull *c.* 13	—	55-60)
					(Dementiev)

1657-58 **Erithacus chrysaeus** subspp.

		Wing	Bill	Tarsus	Tail
♂♂ 1657 *whistleri* (2) (1 by pl.)		66, 67	10.8, 12.2	23.8, 27.7	52, 53
	(IH measurements as in 1658)				
1658 *chrysaeus* (5)		66-69 av. 67.8	9.5-11 av. 10.6	26.7-28.5 av. 27.7	47-54 av. 51.4
	(IH	64-73	from skull 15-16	29-32	51-57)
♀♀ *whistleri* (3)		62, 63, 64	9.9, 10.6, 10.7	27, 27.3, 28	45, 48, 51
			(IH measurements as in 1658)		
chrysaeus (4)		61, 63(2), 64	10, 11.6, 11.8, 12.6	27, 27.4, 27.8, 28.2	49, 50(2), 53
	(IH	60-68	from skull 14-16	28-33	48-54)

1660 **Erithacus hyperythrus**

	Wing	Bill	Tarsus	Tail
♂♂ (2)	77, 78	10.2, 10.8	23, 23.4	53, 58
	(Baker 79-83	from feathers *c.* 10	*c.* 25	54-56)
♀♀ (2)	77, 78	8.8, 10.3	20.9, 21	53, 56
	(Baker 75-79	*c.* 10	*c.* 24	*c.* 52-55)

EL **Erithacus rubecula**

	Wing	Bill	Tarsus	Tail
♂♂				
E. r. hyrcanus (1)	71	12.3	23	—
	(Dementiev 69-74)			
E. r. caucasicus (1)	72	12.2	24	51
	(Dementiev 69-74 av. 72)			
o?				
hyrcanus (5)	69-76 av. 73.4	11.2-12 av. 11.6	22.5-25.3 av. 23.6	52-59 av. 54.8
caucasicus (1)	71	10	23.1	56

EL **Luscinia luscinia**

	Wing	Bill	Tarsus	Tail
♀ (1)	87	12.7	23.3	—
o? (3)	88, 90, 91	12.2, 12.3, 13.2	17, 23.4, 24.4	65, 68, 71

1661-64 **Copsychus saularis** subspp.

		Wing	Bill	Tarsus	Tail
	♂♂				
1661	*saularis* (a) (31)	95-107 av. 100.1	14-18 av. 16.9	25.3-30.2 av. 28.3	78-96 av. 85.5
	,, (b) (5) Burmese	92-100 av. 95.6	17.1-18.9 av. 18.1	24.9-29.7 av. 27.2	78-82 av. 80
		(IH 94-106	from skull 21-23	27-31	79-95)
				(HW, BB, Koelz)	
1662	*ceylonensis* (7)	97-107 av. 102.2	15.1-16.8 av. 15.9	25.7-30.5 av. 27.8	85-94 av. 88.4
		(IH 97-104	from skull 20-22	27-28	81-91)
					(HW)
1664	*andamanensis* (3)	94, 98, 98	18.2, 19.8, 20	26.1, 27, 28.3	86, 86, 89
		(Baker 96-102	*c.* 18	29	87-91)
	♀♀				
1661	*saularis* (a) (17)	92-101 av. 94.9	14.4-18 av. 16.4	24.1-28.5 av. 26.4	76-85 av. 80.3
	,, (b) (3)	89*, 91, 92	14.9*, 17.3, 18.4	24.2, 24.7, 26.3	—, 71 (juv.), 75
		(IH 91-97	from skull 20-22	27-30	79-88)
1662	*ceylonensis* (5)	92-95 av. 93.4	14.8-17.4 av. 16.3	(HW, BB, Koelz)	77-84 av. 79.2
		(IH 94-101	from skull 20-23	25-27.5 av. 26.1	80-86)
1664	*andamanensis* (1)	92	16.7	27-30	(HW)
				25.8	80

1665-68 **Copsychus malabaricus** subspp.

	Wing	Bill	Tarsus	Tail Summer	Tail Winter
♂♂					
1665 *malabaricus* (9)	91-98 av. 94.6	13.5-16.5 av. 15	22.8-25.2 av. 23.7	152-193 av. 172.3	138, 142, 152 av. 144
	(IH 94-99	from skull 18-21	24-27	160-207)	
1667 *indicus* (27)	91-99 av. 95.3	13.5-16.9 av. 15.5	23-26.4 av. 24.3	139-199 av. 161.6	127-170 av. 134.4
	(IH 86-99	from skull 17-22	25-28	108-200)	
1668 *albiventris* (4)	92, 93, 94, 95	14.5, 15, 15.3, 15.3	23, 24.2, 24.9, 25.1	93, 113	112, 115
	(IH 85-89	—	—	91-105)	(Baker)
♀♀					
malabaricus (2)	88, 89	15.3, 16	22.5, 23.7	—	113, 122
	(IH 87-90	from skull 18-20	23-24	113-133)	
indicus (15)	85-92 av. 88.5	13.2-15.9 av. 14.7	21.3-25 av. 23	(2) 108, 111	(13) 86-124 av. 105.5
	(IH 84-93	from skull 18-22	25-27	102-131) (HW, SDR, Rand & Fleming)	
albiventris (3)	*84, 86, 86	*14.6, 14.9, 15	21.9, *22.5, 24.7	96	*86, 91
(1 juv.)*	(IH 85-89	—	—	91-105)	(Baker)

1669 **Phoenicurus erythronotus**

	Wing	Bill	Tarsus	Tail
♂♂ (18)	82-89 av. 87	10-12.4 av. 10.7	19.7-23 av. 21.4	65-74 av. 68.5
	(IH 84-89	from skull 14-16	23-26	64-65) (HW)
♀♀ (8)	82-86 av. 84.5	10.1-11.7 av. 10.7	19.2-21.4 av. 20.3	63-70 av. 67.2
	(IH 81-86	from skull 15-16	23-27	64-72) (HW)

1670 **Phoenicurus caeruleocephalus**

	Wing	Bill	Tarsus	Tail
♂♂ (16)	76-85 av. 81.5	9.8-12.5 av. 11	17.8-21.2 av. 19.3	60-66 av. 61.6
	(IH 80-84	from skull 15	*c.* 22	*c.* 65)
♀♀ (13)	74-82 av. 78.5	9.7-11.7 av. 10.5	18.2-21 av. 19.9	57-65 av. 59.5
	(IH 76-84	from skull 15	*c.* 22	*c.* 65)

(MD, wing by Rand & Fleming)

1671/72 **Phoenicurus ochrurus** subspp. & EL

	Wing	Bill	Tarsus	Tail
♂♂				
1671 *phoenicuroides* (45)	77-85 av. 82	10-13.5 av. 11.4	19.3-23.5 av. 21.8	54-64 av. 60.1
	(IH 80-89	from skull 15-16	23-24	60-65)
1672 *rufiventris* (29)	84-93 av. 88.5	9.5-13.3 av. 11.3	17.8-26.5 av. 22.4	56-65 av. 61.1
	(IH 84-93	from skull 14-15	25-26	60-65)
EL *ochrurus* (6)	80-84 av. 82.1	10.5-12.9 av. 11.6	21.1-23.3 av. 21.9	55-60 av. 59.2
	(Dementiev 80-85)			
♀♀				
phoenicuroides (21)	77-85 av. 81.4	10.6-12.7 av. 11.5	19.7-24 av. 22.1	53-65 av. 58.7
	(IH 77-81	from skull 15-16	23-24	55-60)
rufiventris (6)	79-86 av. 84	10-11.7 av. 10.9	21-23.1 av. 22.2	58-68 av. 62
	(IH 82-88	from skull 14-15	24-25	56-64)
EL *ochrurus* (5)	79-82 av. 80.8	10.5, 11, —, —, —	21.1-22.5 av. 21.8	55-60 av. 57.8
	(Dementiev 80-82)			

1673 & EL **Phoenicurus phoenicurus** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1673 *phoenicurus* (16)	76-83 av. 79.8	10-11.7 av. 10.8	18.9-21.8 av. 20.3	52-59 av. 56.2
	(Dementiev 74-82 av. 77.2)	from skull 13-14		55-64)
EL *samamisicus* (5)	77-81 av 79.2	9.6-11.4 av. 10.5	18.5-21.2 av. 19.4	53-58 av. 55.2
	(Dementiev 76-85 av. 79.1)			
♀♀				
phoenicurus (5)	74-89 av. 80.2	10-12 av. 10.9	17.5-22.6 av. 20.2	51-57 av. 55
	(Dementiev 73-84 av. 77.4)	from skull 13-14	—	55-64)

1674 **Phoenicurus hodgsoni**

	Wing	Bill	Tarsus	Tail
♂♂ (7)	84-88 av. 85.8	10.8-12.5 av. 11.5	20.7-25.1 av. 22.4	62-71 av. 66
	(IH 82-88	from skull 15-17	23-25	63-71)
♀♀ (7)	77-83 av. 80.2	10.1-12 av. 10.9	21.9-23.6 av. 22.5	61-67 av. 63.1
	(IH 76-84	from skull 14-17	22-24	60-70)

1675 **Phoenicurus frontalis**

	Wing	Bill	Tarsus	Tail
♂♂ (24)	83-91 av. 86.8	10-11.9 av. 10.8	20.2-24 av. 21.8	63-70 av. 65.8
	(IH 84-93		24-25	65-76)
♀♀ (8)	80-85 av. 83.1	9.8-11.5 av. 10.5	19.8-23.6 av. 21.7	62-70 av. 64.1
	(IH 80-87	from skull 14-16	21-25	64-70)
o? (4) 1 *fledgling*	80, 85, 85	11.1, 11.5, 11.8	21, 21.2, 21.5	60, 61, 66

1676 Phoenicurus schisticeps

	Wing	*Bill*	*Tarsus*	*Tail*
♂ (1) pl.	85	10	22.8	67
	(IH 81-87	from skull 15-17	24-25	66-70)
♀♀ (3)	81, 82, 85	11.9, 12.1, 12.2	21. 21.6, 22	66, 66, 73
	(IH 76-85	from skull 15-17	23-25	64-73)

1677 Phoenicurus auroreus leucopterus

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (4)	73, 74, 74, 77	10.5, 12.1, 12.1, —	20.1, 20.8, 21.5, 21.8	59, 60, 61, 61
♀♀ (7)	71-76 av. 72.5	9.6-12 av. 11.2	18.8-22.6 av. 21	57-62 av. 58.8
	(Baker ♂♀ 70-77	from skull *c.* 15	23	58-60)

1678 Phoenicurus erythrogaster grandis

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (10)	100-113 av. 105	11.5-14.3 av. 12.7	22-26 av. 24.5	70-76 av. 72.7
	(IH 101-115	from skull 17-18	28-30	70-75)
♀♀ (6)	99-108 av. 102.8	11.3-13.3 av. 12.1	21.7-25.2, av. 23.7	72-76 av. 74.3
	(IH 95-106	from skull 15-17	27-28	71-75)

1679 Rhyacornis fuliginosus

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (21)	72-79 av. 76.4	8.9-11.3 av. 10	18.3-21.9 av. 20.3	42-56 av. 50.6
	(IH 72-80	from skull 13-16	22-24	50-57)
♀♀ (8)	70-72 av. 70.6	8.8-10.8 av. 9.9	17.5-19.8 av. 18.9	41-48 av. 45.5
	(IH 68-83	from skull 13-14	21.24	46-58)

EL Irania gutturalis

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (2)	96, 97	14.4, 16	22.3, 25.1	73, 74
	(Dementiev 91-95	from skull 18-20	—	*c.* 80)
♀♀ (3)	92, 93, 94	13.5, 13.7, 14.1	21, 25, —	66, 69, 70
	(Dementiev 86-95	from skull 18-20		*c.* 80)

1680 Hodgsonius p. phoenicuroides

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (4)	71, 71, 72, 75	13.6, 14.1, 14.5, —	28, 29, 30.4, 30.7	67, 74, 83, —
	(IH 72, 74	from skull 18-19	*c.* 30	77, 79)
♀ (1)	72	14.8	27.7	76
	(IH 69-72	from skull 18-19	*c.* 30	76-78)

1681 Cinclidium leucurum

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (17)	92-102 av. 95.7	12.5-16 av. 14.7	23.6-26.5 av. 25.5	66-86 av. 73.9
	(IH 89-100	from skull 18-19	27-29	69-85)
♀♀ (9)	86-95 av. 88.7	13-15.1 av. 13.9	23-25.6 av. 24.5	55-63 av. 60.4
	(IH 88-91	—	—	—)

	Wing	Bill	Tarsus	Tail
1683 Grandala coelicolor				
♂♂ (8)	144-149 av. 146.3	14-17 av. 15.2	24.4-28.1 av. 26	81-90 av. 85.6
	(IH 140-152	from skull 20-22	29-31	84-91)
♀♀ (3)	140, 142, 148	13.8, 15.9, 18.3	23, 24.9, 27	71, 79, 83
	(IH 135-147	from skull 20-22	29-30	77-87)
1684 Enicurus s. scouleri				
♂♂ (7)	73-80 av. 75.7	10.4-11 av. 10.7	18.8-23.9 av. 22.9	45-52 av 47.6
♀♀ (13)	71-77 av. 73.8	9.3-13.4 av. 10.7	18.1-25.9 av. 22	42-51 av. 45.6
	(IH ♂♀ 72-79	from skull 13-15	24-26	41-51)
1685 Enicurus immaculatus				
♂♂ (9)	90-95 av. 92.3	15.5-17.3 av. 16.3	23.5-26.6 av. 24.7	95-122 av. 111.1
	(IH 86-98	from skull 20	*c* 26	124)
♀♀ (2)	92, 94	16.4, 17.6	25, 25.5	70, 107
	(IH 86, 90	from skull 20	*c* 26	127)
1686 Enicurus schistaceus				
♂♂ (11)	95-102 av. 99	17.5, 19.3 av. 18.3	25.7-29.5 av. 27.1	110-137 av. 115.4
♀♀ (4)	95, 96, 97, 99	15.8, 16, 17.7, 18.2	26, 26.2, 26.5, 27.2	122, 123, 125, 128
	(IH ♂♀ 91-104	from skull 19-23	28-32	117-140)
			(HW, SA, BB)	
1687 Enicurus leschenaulti				
♂♂ (2)	114, 119	23.3, 31.2	31, 32	134, 135
♀ (1)	104	20.3	30.2	120/124
	(IH ♂♀ 98-114	from skull 26-29	30-32	128-150)
1688/9 Enicurus maculatus subsp.				
♂♂				
1688 *maculatus* (12)	102-115 av. 108.4	16-20.6 av. 18.7	25.5-28.3 av. 26.9	102-148 av. 122
	(IH 108-111	from skull 24-25	*c* 30	146-150)
1689 *guttatus* (2)	97, 107	18.5, 18.8	25, 29.3	113, 132
♀♀				
1688 *maculatus* (10)	98-113 av. 105.5	17-20.5 av. 19.2	23.4-29.1 av. 27.1	109-146 av. 133
	(IH 99-110	from skull 22-24	—	129-139)
1689 *guttatus* (1)	94	16.7	25.3	115
	(IH ♂♀ 95-106	from skull 21-23	28-31	118-143)
1690 Cochoa purpurea				
♂♂ (3)	140, 145, 150	19.2, 20, 20	18.5, 24, 26	95, 105, 110
♀ (1)	139	18.7	27.5	98
	(IH ♂♀ 140-145	from skull 23-24	28-31	95-105)

(*to be continued*)

GEOGRAPHICAL DISTRIBUTIONAL LIST OF ICHTHYOFAUNA OF THE GARHWAL HIMALAYA WITH SOME NEW RECORDS[1]

H. R. Singh, S. P. Badola and A. K. Dobriyal[2]

(*With a text-figure*)

This paper deals with the fish fauna and their distribution in different river systems of the Garhwal Himalaya. In all 69 species of fishes have been reported. Of them many fishes inhabit the coldwater streams but some are fishes of the foothills and plains.

Introduction

The fish fauna of the neighbouring Himachal Pradesh, Jammu and Kashmir Himalaya have been studied by Heckel (1844), Silas (1960), Das & Subla (1964), Malik (1966), Saxena (1968) and Sehgal *et al.* (1971). There are many reports on the fish fauna of other parts of Uttar Pradesh including those on the fishes of Muzaffarnagar (Mahajan 1961), Moradabad (Singh 1974), Meerut (Sinha & Shiromani 1953), Aligarh (Sehgal 1973), Eastern U.P. (Srivastava 1968), Pilibhit (Motwani & Saigal 1974), Banda (Grover & Gupta 1977), Corbett National Park (Husain 1975), and Kanpur (Verma *et al.* 1962), etc. The fish fauna of the adjoining Kumaon hills has been described by Hora (1937), Menon (1949a, 1949b, 1962, 1971), Chaudhury & Khandelwal (1960), and Pant (1970). But the reports on the fish fauna of the Garhwal hills have been very scanty and limited to Dehradun district only (Hora & Mukerji 1936, Das 1960, Lal & Chatterjee 1962, Singh 1964, Tilak & Husain 1973).

As no information was available on the fish fauna of the remaining four districts, namely Pauri, Tehri, Chamoli and Uttarkashi, an extensive survey was made by the authors. In the earlier papers (Badola & Pant 1973; Badola 1975; Badola & Singh 1977*a* & *b*) 18 species from Uttarkashi, 43 species from Pauri, 28 species from Chamoli, and 33 species from Tehri district were reported. Recently Badola & Singh (1981) described the fish and fisheries of the River Alaknanda and Singh & Dobriyal (1982) published the first report on the occurrence of *Botia geto* in the River Alaknanda of the Garhwal Himalaya. The present paper aims at describing the distribution of fishes in different rivers of the Garhwal Himalaya (Table 1) and the 27 new species which were not included in the earlier reports.

Physiographic features

The Garhwal Himalaya forms the western part of the Uttar Pradesh hills. This region is situated between the latitudes 29°26′-31°28′N and longitude 77°49′-80°6′E with a total area of about 30,090 km^2. The north region extends up to the snow-clad peaks making the Indo-Tibetan boundary. The river Tons separates it from Himachal Pradesh in the west, and the Kumaon hills in the east. Geographically, the

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TABLE 1

DISTRIBUTION OF FISHES IN IMPORTANT RIVER SYSTEMS OF THE GARHWAL HIMALAYA

Name of the species	Alaknanda	Birahi	Nandakini	Pinder	Mandakini	Bhagirathi	Jamuna	Ganga	Nayar	Bhilangana	Hinwal	Khoh & Malan	Rawasan	Song & Suswa
1. *Schizothorax richardsonii* (Gray)	a	a	a	a	a	a	a	c	c	c	c	n	n	n
2. *Schizothorax sinuatus* Heckel	a	a	a	a	a	a	a	c	c	c	c	n	n	n
3. *Schizothorax plagiostomus* Heckel	a	a	a	a	a	a	a	c	c	c	c	n	n	n
4. *Schizothorax curvifrons* Heckel	a	c	c	c	c	c	c	c	n	c	n	n	n	n
5. *Schizothorax niger* Heckel	c	c	c	c	c	c	c	c	n	c	n	n	n	n
6. *Schizothorax intermedius* McClelland	c	c	c	c	c	c	c	c	n	c	n	n	n	n
7. *Schizothorax micropogon* Heckel	c	c	c	c	c	c	c	c	n	c	n	n	n	n
8. *Schizothoraichthys progastus* (McClelland)	c	c	c	c	c	c	c	c	r	r	n	n	n	n
9. *Schizothoraichthys esocinus* (Heckel)	c	c	c	c	c	c	c	c	r	r	n	n	n	n
10. *Tor tor* (Ham.)	c	r	r	c	c	c	c	a	c	r	c	r	r	c
11. *Tor putitora* (Ham.)	c	r	r	c	c	c	c	a	c	r	c	r	r	c
12. *Tor chilinoides* (McClell.)	c	c	c	c	c	c	c	r	c	c	c	n	n	r
13. *Labeo dero* (Ham.)	c	n	r	c	c	c	c	a	c	c	c	c	c	c
14. *Labeo dyocheilus* (McClell.)	c	n	r	c	c	c	c	a	c	c	c	c	c	c
15. *Labeo boga* (Ham.)	n	n	n	n	n	n	n	c	c	n	c	c	c	c
16. *Puntius chola* (Ham.)	n	n	n	n	n	n	n	c	r	n	c	c	c	c
17. *Puntius ticto* (Ham.)	n	n	n	n	n	n	n	c	c	n	c	a	a	a
18. *Puntius conchonius* (Ham.)	n	n	n	n	n	n	n	c	c	n	c	a	a	a
19. *Puntius sarana* (Ham.)	n	n	n	n	n	n	n	a	r	n	r	c	c	c
20. *Puntius phutunio* (Ham.)	n	n	n	n	n	n	n	c	n	n	n	c	c	c
21. *Puntius sophore* (Ham.)	n	n	n	n	n	n	n	c	n	n	n	c	c	c
22. *Garra prashadi* (Hora)	c	n	n	c	c	c	c	c	a	c	a	a	a	a
23. *Garra lamta* Ham.	c	r	c	c	c	c	c	c	c	r	a	a	a	a
24. *Garra gotyla gotyla* (Gray)	c	r	c	c	c	c	c	c	c	c	a	a	a	a
25. *Crossocheilus latius latius* (Ham.)	c	r	c	c	c	c	c	c	c	c	c	c	c	c
26. *Chagunius chagunio* (Ham.)	n	n	n	n	n	n	n	c	c	n	c	c	c	c
27. *Barilius bola* (Ham.)	r	n	n	n	n	c	c	a	c	r	c	c	c	c
28. *Barilius bendelisis* (Ham.)	c	r	r	c	c	c	c	a	a	c	a	a	a	a
29. *Barilius barna* (Ham.)	c	n	r	c	c	r	c	a	a	c	a	a	a	a
30. *Barilius barila* (Ham.)	c	n	r	c	c	r	c	a	a	c	a	a	a	a
31. *Barilius vagra* (Ham.)	c	n	r	c	c	r	c	a	a	c	a	a	a	a
32. *Barilius shacra* (Ham.)	n	n	n	n	n	n	n	r	r	n	r	r	r	n
33. *Rasbora daniconius* (Ham.)	n	n	n	n	n	n	n	c	c	n	c	c	c	c
34. *Danio* (*Danio*) *aequipinnatus* (McClell.)	n	n	n	n	n	n	r	a	r	n	c	a	a	a
35. *Danio* (*Brachydanio*) *rerio* (Ham.)	n	n	n	n	n	n	n	c	n	n	n	c	c	c
36. *Danio*(*Danio*) *devario* (Ham.)	r	n	n	n	n	n	n	a	r	n	r	a	a	a
37. *Esomus danricus* (Ham.)	n	n	n	n	n	n	n	c	r	n	n	c	c	c
38. *Botia dario* (Ham.)	r	n	n	n	n	r	r	c	c	r	c	c	c	n
39. *Lepidocephalus guntea* (Ham.)	r	n	n	n	n	n	n	a	r	n	r	a	a	a
40. *Noemacheilus botia* (Ham.)	n	n	n	n	n	n	n	c	n	n	r	a	a	a

TABLE 1 (CONTD.)

Name of the species	Alaknanda	Birahi	Nandakini	Pinder	Mandakini	Bhagirathi	Jamuna	Ganga	Nayar	Bhilangana	Hinwal	Khoh & Malan	Rawasan	Song & Suswa
41. *Noemacheilus montanus* (McClell.)	a	a	a	a	a	a	a	r	r	a	r	n	n	n
42. *Noemacheilus rupicola* (McClell.)	a	a	a	a	a	a	a	a	a	a	a	a	a	a
43. *Noemacheilus bevani* Gunther	a	a	a	a	a	a	a	a	a	a	a	a	a	a
44. *Noemacheilus savona* (Ham.)	a	a	a	a	a	a	a	a	a	a	a	a	a	a
45. *Noemacheilus multifasciatus* Day	a	a	a	a	a	a	a	c	c	c	c	n	n	n
46. *Noemacheilus scaturigina* (McClell.)	n	n	n	n	n	n	n	c	n	n	c	c	c	c
47. *Noemacheilus zonatus* (McClell.)	c	c	c	c	c	c	c	n	n	n	n	n	n	n
48. *Noemacheilus corica* (Ham.)	n	n	n	n	n	n	n	n	n	n	n	r	r	a
49. *Balitora brucei* Gray	n	n	r	r	r	n	n	n	r	r	n	n	n	n
50. *Amblyceps mangois* Ham.	r	n	n	n	n	n	n	r	n	n	r	r	r	r
51. *Glyptothorax cavia* (Ham.)	c	c	c	c	c	c	c	c	c	c	c	r	r	n
52. *Glyptothorax pectinopterus* (McClell.)	c	c	c	c	c	c	c	a	a	c	a	a	a	c
53. *Glyptothorax madraspatanum* (Day)	c	c	c	c	c	c	n	n	c	n	n	n	n	n
54. *Glyptothorax trilineatus* Blyth	c	c	c	c	c	c	n	n	c	n	n	n	n	n
55. *Glyptothorax telchitta* (Ham.)	n	n	n	n	n	n	n	n	n	n	n	c	c	n
56. *Glyptothorax brevipinnis* (Hora)	c	c	c	c	c	c	c	c	c	c	c	c	c	n
57. *Glyptothorax conirostris* (Steindachner)	c	c	c	c	c	c	c	c	r	c	r	n	n	n
58. *Pseudecheneis sulcatus* (McCell.)	c	c	c	c	c	c	c	r	r	c	r	n	n	n
59. *Clupisoma garua* (Ham.)	r	n	n	r	n	r	r	c	r	r	r	n	n	n
60. *Mystus vittatus* (Bloch)	n	n	n	n	n	n	n	c	n	n	n	c	c	c
61. *Channa gachua* (Ham.)	n	n	n	n	n	n	n	c	n	n	n	a	a	a
62. *Xenentodon cancila* (Ham.)	n	n	n	n	n	n	n	n	n	n	n	c	c	c
63. *Mastacembelus armatus* (Lac.)	n	n	n.	n	n	r	r	c	c	c	c	a	a	a
64. *Botia geto* (Ham.)	r	–	–	–	–	–	–	–	–	–	–	–	–	–

a = abundant, c = common, n = nil, r = rare

Garhwal Himalaya has been divided into: (i) The Greater Himalaya with snow peaks having a height of about 7817 m (Nanda Devi) above the sea level, and (ii) the lower Himalaya (middle) with peaks and valleys, and (iii) the Siwaliks with Siwalik ranges and the "Bhabar" (foothills). The 'bhabar' region has a height of about 325 m above the sea level. The Garhwal region comprises the districts of Chamoli, Uttarkashi, Pauri, Tehri and Dehradun, the first two being border districts.

Most of the holy rivers of India owe their origin to the snow peaks of Chamoli and Uttarkashi districts of this region. There are a large number of snow-fed rivers and streams such as the Jamuna, the Alaknanda, the Bhagirathi, the Jar ganga, the Asi ganga, the Dhauli ganga, the Mandakini, the Pinder, the Nandakini, and the Ganga (at Deoprayag the two parent streams, namely the Alaknanda and the Bhagirathi, meet and form the Ganga). Besides the snow-fed rivers there are many non-snow-fed rivers such as the Birahi, the Nayar, the Khoh, the Malan, the Tal, the

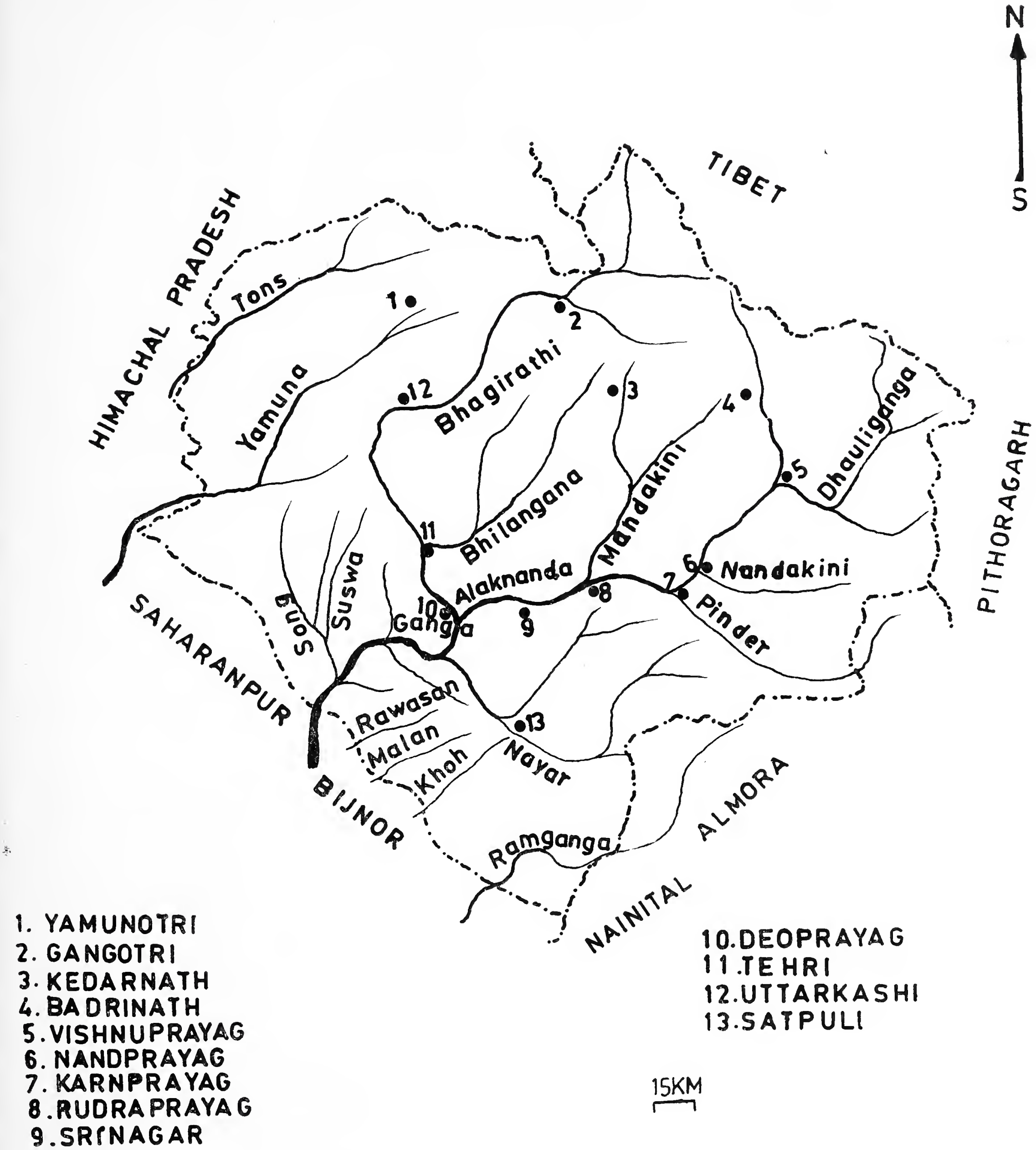

Fig. 1. Garhwal Himalaya river systems.

Rawasan, the Bhilangana, the Hinwal, the Gular, the Lastar, the Badiyar, the Song, and the Suswa, etc. and hundreds of rivulets. They all contain a very rich and colourful fish fauna. However, many of them have so far remained unexplored, because in the past the various regions of the Garhwal Himalaya were inaccessible due to lack of transport facilities. But now many areas are well linked with motorable roads and this helped the authors in surveying the fish fauna of the Garhwal Himalaya.

Discussion

Fish fauna of the Garhwal includes a large number of coldwater fishes. *Schizothorax, Schizothoraichthys* and *Pseudecheneis* species are the fish which always prefer the snow-fed Greater Himalayan rivers and streams, such as the Bhagirathi, the Jamuna, the Alaknanda, the Nandakini, the Pinder, and the Mandakini, etc. *Garra, Crossocheilus, Noemacheilus* and *Glyptothorax* species are also commonly found in the snow-fed and the non-snow-fed rivers from the Greater Himalaya to the foothills (Siwalik) of this region. *Tor tor, T. putitora*, and *Labeo dyocheilus* are not found throughout the year in the snow-fed rivers. These species start their migration from the Siwalik ranges to the snow-fed rivers from March to June for the purpose of breeding and thereafter they return to their native places. *Tor chilinoides* and *Balitora brucei* are also found in the high altitude rivers. *Barilius* species always prefer non-snow-fed rivers but they were also observed in the sidewaters of the snow-fed rivers of the Greater Himalayas. They migrate towards the uplands in the rainy season and inhabit and breed in the sidewaters of the Alaknanda, the Bhagirathi, and the Jamuna etc. *Botia dario, Barilius bola, Chagunius chagunio, Clupiosoma garua* and *Mastacembelus armatus* were frequently seen during the rainy season in the lower reaches of the snow-fed rivers.

Some of the fishes (*Labeo boga, Puntius sarana, P. chola, P. ticto, P. sophore, P. phutunio, P. conchonius, Rasbora daniconius, Danio* sp., *Esomus danricus, Lepidocephalus guntea, Noemacheilus botia, N. corica, Amblyceps mangois, Mystus vitattus, Channa gachua*, and *Xenentodon cancila*) could not be seen in the snow-fed rivers. These fishes were common in the foothills (Siwalik ranges) adjoining the plains. They were common in the rivers like Khoh, Malan, Rawasan, Hinwal, Tal, Gular, and the backwaters of the Ganga river.

The exotic fish *Salmo trutta fario* (brown Trout) was introduced at Kaldayani hatchery (Uttarkashi) from Kashmir in 1910. This hatchery is situated at an elevation of 1540 m on the bank of the snow-fed river Asiganga, a tributary of the Bhagirathi; *Salmo gairdneri* (rainbow trout) was introduced at Talwari hatchery (Chamoli) in 1964. This hatchery is situated at an elevation of 1770 m and is fed by a natural spring. *Cyprinus carpio* has been introduced recently at Talwari hatchery from Bhimtal (Nainital).

Twenty seven fishes which were not mentioned in the earlier papers and are being reported now are: *Salmo trutta fario, Salmo gairdneri, Schizothorax curvifrons, S. niger, S. intermedius, S. micropogon, Schizothoraichthys esocinus, Labeo boga, Puntius sophore, P. chola, P. sarana, P. phutunio, Barilius bola, Rasbora daniconius, Esomus danricus, Cyprinus carpio* var. *communis, Cyprinus carpio* var. *specularis, Botia geto, B. dario, Noemacheilus scaturigina, Amblyceps mangois, Clupisoma garua, Mystus vittatus, Glyptothorax cavia, G. brevipinnis, Euglyptosternum lineatum* and *Xenentodon cancila.*

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SUNDARBANS HONEY AND THE MANGROVE SWAMPS[1]

KALYAN CHAKRABARTI[2]

The present paper discusses various aspects of honey production and the behaviour pattern of the honey bees in the estuarine tracts of the Sundarbans where the terrain is peculiar, the environment is tropical and humid, wind velocity is high and the forests are dense and low. It covers the aspects of (i) annual honey and wax production and corresponding number of the permit holders and their casualties from man-eaters, (ii) the size pattern of the honey combs and corresponding honey production; (iii) honey production relating to the distance of honey comb from the ground level; (iv) host-comb relationship; (v) nectar, pollen grains and colour of honey; (vi) phenology of forest plants. The observations have been statistically analysed and the findings clearly stated and represented. These aspects of *Apis dorsata* have never been studied in such detail in estuarine tract in its natural habitat and the results of the observations has economic significance and will help at better work schedule for honey collection.

THE TRACT

The vast expanse of tidal swamp forests of the Sundarbans studded with fantastic labyrinths, bifurcations of rivers around tiny mud-flats are one of the thickest and impenetrable forests, where the honey bee (*Apis dorsata*) migrate during March to June every year. Numerous swarms of bees are ceaselessly active in collecting nectar from the vast tracts of forests flushed with fragrant flowers and forming huge low combs, close to the ground level. In a tract where venomous snakes, sharks, crocodiles, tigers and spotted deer occur. Honey collection in this animal infested terrain, where the forests are impenetrable, mud extremely soft, land inundated twice a day by high tide, innumerable sharp and hard pneumatophores point dangerously above ground level, is the most hazardous, laborious and risky among all type of work in the Sundarbans forests.

OBJECT OF STUDY

The study has been initiated to ascertain (i) the percentage of different plant species that form the host plant of the honey bees, (ii) if the bees are selective of any particular plant or plants for making combs and what is the percentage of different host plant species; (iii) if the comb size has any relation with the yield of honey and wax; (iv) if the height of comb from the ground level has any relation with yield of honey and wax; (v) if the pollen analysis of honey samples can indicate the nectar preference for any particular flower or flowers; (vi) the peak period of production; and (vii) the death pattern of the honey collectors and other permit holders from the tigers.

METHODS OF STUDY

A large number of honey combs were inspect-

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ed in different parts of forests over a wide area. The measurement of length, width and thickness were noted and honey and wax production for each comb was measured. These observations were also made by the field foresters and forest guards all over the forests (the tract is extensive and difficult) and recorded in proforma sheets specially made for this purpose. A number of honey collectors were also questioned and their observations were recorded. All these observations were later summarised. Samples of honey were microscopically examined and the host plants were identified from the pollen grains. Total collections from time to time were enumerated and correlated with flower production; fortnightly collections of honey were measured and continued for a period of 75 days.

Host plants

The bees showed the following perference percentages to trees for making honey combs

Avicennia sp.	—	16.0%
Heritiera formes	—	9.0%
Xylocarpus ganitrus	—	2.8%
X. gangeticus	—	1.9%
Rhizophora mucronata	—	10.0%
Cereops sp.	—	11.0%
Agialitis rotundifolia	—	1.0%
Excoecaria agallocha	—	39.0%
Aegiceros corniculatus	—	0.5%
Sonneratia apetala	—	5.3%
Bruguiera gymnorrhiza	—	3.5%

Excoecaria trees are an obvious choice. although this tree does not either have a suitable crown or spreading branches. *Phoenix-Excoecaria* combination offers an ideal habitat for the honey comb formation. The cool atmosphere and moisture laden tunnel formed by *Phoenix* palm with the *Excoecaria* branches hanging over the thickets have the maximum number of combs per unit area. Contrary to this, *Sonneratia apetala,* the tallest and much branched tree of the Sundarban forests does not have sufficient number of combs. *Xylocarpus* species are avoided although the trees have thick dense crown and are branched; yet *Heritiera* with its sporadic occurrence and light thin crown have a good percentage of combs in them. *Cereops* species which occupy 90% of the forest areas have only 11% of the combs; the reasons may be the shrubby bushes of C. *roxburghiana* and unbranched thick crown of *C. candolleana* both of which are found unsuitable for comb formation. The *Rhizophora* and *Avicennia* (*A. alba* and *A. officinalis*) have proportionately high percentage of combs although the trees grow only along the island boundary and beside the creeks, *khals* and rivers. The honey bees avoid such trees growing open or along a wide *khal* which is evident from complete absence of the combs on the trees standing along the boundary of islands that generally form the inspection route of the forest staff. Contrary to this, these species when they occur along narrow creeks inside the islands have a good number of combs.

Comb sizes and the yield of honey and wax

A number of honey combs occurring all over the forests were measured. It has been found that width and thickness are rather constant in all cases but the length is variable. The average calculated from the measurements is given below:

	Length	Width	Thickness
Maximum	120 cm	95 cm	7.5 cm
Average	75–90 cm	37–45 cm	6.0 cm
Minimum	37–45 cm	25 cm	6.0 cm

Honey yield corresponding to all available sizes was noted and the results of yield with size and distance from the ground level were analysed statistically. From actual measure-

ment it has been found that combs of 0.028 cubic meter volume yield about 3 kg of honey, combs of 0.035 cu. m. yield about 4-6 kg., combs of 0.042 cu. m. yield about 10 kg, and 0.056 cu. m. about 14 kg of honey, but the last two sizes are not of general occurrence.

But the honey output possibly depends on various factors like (i) proper strain of honey bee; (ii) ideal weather condition; (iii) size of comb; (iv) first or second formation; (v) distance from ground level; (iv) optimum flowering of tree species, and other factors.

A swarm of bees generally form only one honey comb on a tree however branched and wide-crowned the trees may be. It is only in 5 to 10% cases that two honey combs are formed on a tree. In such cases one becomes bigger and the other smaller. These perhaps are formed when there are two queen bees in a swarm. Not a single tree was found with three combs. Generally all the combs are constructed on a new site although the waxy bases of honey combs are left out on the branches to invite the honey bees to form combs for a second time. It is only in 7.3% cases that a second comb has been found constructed on the left-out waxy base of the first hive. The combs on slanting branches have been found to yield more honey than those on horizontal branches. Honey accumulates on the lower portions of the comb.

It has been found that the combs made early in the season are bigger in size. The combs that face at right angles to the rays of the sun have high honey contents.

Comb distance from the ground level and honey yield

Honey combs are formed at a very low height contrary to the comb-formation by this very species elsewhere. The trees in these forests are 5 to 10 metres tall, yet few combs are made above 4-5 metres from the ground level. Optimum height is 1.5 to 2.0 metres from the ground level. A survey of 406 trees showed that only ten trees contained combs above 2.5 metres from the ground level; the rest were at heights from 1.5 to 2.5 metres.

An effort has been made to find out a definite relationship between honey yield with length of honey comb and distance from the ground level. It shows that honey yield has a definite relation with the size. Normally, with the increase in the distance of the comb from the ground level there is an increase in the yield of honey up to the height of 2.59 metres. Any increase in height beyond that meant decrease in the yield of honey.

Another clear observation made was that during the last phase of honey comb-formation, low level branches were avoided and higher branches selected. It is because the forest environment close to ground gets hot at the lower levels. For the comb-formation for the second time *Avicennia, Sonneratia, Bruguiera* and *Rhizophora* species are selected. Honey combs formed in the *Excoecaria-Phoenix* formation were found at a height as low as 60 to 240 cm from ground level. (In *Phoenix* area the high tide water does not reach the tree level. Crabs have been found to eat honey in these combs.)

The honey combs that are made for the second time have four characteristics:

(i) They are made far above ground level.
(ii) They are smaller in size, but
(iii) They yield comparatively more honey.
(iv) The quantity of wax is proportionately more than the first formation.

Honey combs which are formed at the fag end of the season from *Excoecaria agallocha* nectar are smaller in size, but the honey content is comparatively more. Statistical analysis of random sample of 60 combs suggests that in 98% cases the distance of honey comb

from the ground level lies within 1.5 to 2.1 metres. But the optimum distance of honey comb which yields the maximum quantity of honey has been found to be 2.5 metres other factors remaining constant.

Phenology and honey production

The phenological pattern shows the peak period of flowering of different species of flowering plants. This can be divided into several 15-day phase as follows

Phase I
- March 20th to April 5th
- *Aegiceros corniculatus*
- *Acanthus illicifolius*
- *Suaeda maritima* and
- *Sisuvium portulacastrum*
- March 31st to April 15th
- *Phoenix paludosa*
- April 5th to April 20th
- *Cereops* sp.

Honey formed from the first four flowers has thick consistency and is creamy white in colour. Honey made from *Aigeceros* nectar is considered best and is cream coloured. Honey from *Cereops* is a bit reddish.

Phase II April 15th to May 5th

Sonneratia apetala

Honey derived out of these flowers is yellowish and slightly light.

Phase III May 1st to May 20th

Avicennia sp.

The honey has reddish tinge and is light.

Phase IV May 20th to June 5th

Excoecaria agallocha

The honey has reddish colour and its taste is slightly acidic and hot. It has fermented effect and burns the throat. The bulk collection of honey occurs in the following sequence from April to June. The results are shown as follows:

April 1st to April 15th	—	40.8%
April 16th to April 30th	—	33.2%
May 1st to May 15th	—	20.0%
May 16th to May 31st	—	4.4%
June 1st to June 15th	—	1.6%

This gives an impression that the bulk of the honey is produced from *Aegiceros corniculatus, Xylocarpus* species, *Acanthus illicifolius* (a shrub), *Phoenix paludosa* and *Cereops.*

Similarly the honey that is collected during the latter half of April is mainly from *Sonneratia* and *Cereops.* The last phase of collection is from a mixture of many species of which *Excoecaria agallocha* contributes maximum (verified from the pollen study).

But analysis of a few samples of honey under the microscope also shows the pollen grains of several species that do not even occur in the reserved forests area or in the vicinity. Such analysis shows good quantity of *Cereops* pollen and the pollen of *Crotalaria* and several other species that do not occur in the Sundarban forests.

Nectar, Pollen production and weather

Nectar is a product of glandular secretion. All the flowering trees of the Sundarbans have small and fragrant flowers (*Acanthus illicifolius* and *Derris* species have bigger flowers). Nectar and pollen grains are food of the bees. The coloration in honey, is held by some experts to be, due to climatic conditions and also owing to the chemical composition of the nectar. The pollen grains of the following species have been found mixed with honey:

Acanthus illicifolius	— Yellow pollen grain
Rhizophora mucronata	— Cream coloured grain
Bruguiera gymnorrhiza	— Vermillion coloured grain
Xylocarpus sp.	— Yellow to deep brown grain
Cereops sp.	— Cream coloured grain
Phoenix paludosa	— Red coloured grain

They do impart some colour to the honey.

Why does the honey bee, *Apis dorsata,* migrate to the Sundarban forests during March to July? Do the vast low forests with profuse, nectar yielding, fragrant flowers attract them? In migrating to these forests they have to cover hundreds of miles and work in an atmosphere where humidity varies from 75% to 85%. They work during the period in tropical humid climate, yet the bees detest continuous rain on bright sunny days, the former being detrimental to flush of flower and nectar formation, and the latter for changing the optimum humidity and temperature level. Sunny days with intermittent rains are ideal for honey production. Excessive rain or lack of rain affects normal honey production. Storms in the flower flushing season damage the flowers. The best nectar, it is said, is produced under the influence of suitable soil and in favourable climate; the Sundarbans perhaps provide such a soil and climate.

Honey bee and Wildlife

The honey bee operates in an area where the entire land mass is flooded in high tide and the land animals have to lead an amphibious life. Most important land animals are tigers, spotted deer, pigs and monkeys (*Macaca mulatta*). It has been observed that the monkeys and tigers are interested in honey and they do break the low-lying combs. The monkeys are said to smear the body with a thick layer of silt before approaching the combs! Crabs (*Scylla, Portunus,* and *Mutala* spp.), have been found clinging to the combs. Even though some aquatic mammals like the little porpoise, lizards (*Varanus* sp.), brackish water snakes (*Natrix, Enhydris, Gerardia* spp.), terrestrial snakes (*Naja, Dryophis, Python* spp.) and *Crocodylus porosus* live near the low-lying combs, yet the honey bees, it seems, are unconcerned. It is not known why the combs are made within easy reach of animals. Gastropods (*Nerita, Telescopium, Melongena, Lymnaea, Orchidium* spp.) may be associated with the comb in some way or the other.

But the profession of honey collection is associated with a tragic human problem. On an average over the last twenty years it is recorded that about 1000 honey collectors are engaged each year in this profession, amongst whom 10 fall victim to man-eaters, another 30 are attacked and robbed by dacoits. The annual average of honey collection was 450 quintals and wax about 40 quintals for the last twenty years.

Conclusion

The present study is a preliminary investigation. It has enabled us to find out the principal plant species responsible for best honey production, the best size and height of the combs from the ground level that yield maximum honey, and many other relevant information not so far recorded from this area. The findings have economic significance and it should be possible to manage the forests and formulate better work schedule for honey collection.

ANNUAL REPRODUCTIVE CYCLE OF THE MALE FIELD RAT, *RATTUS RATTUS BRUNNEUSCULUS* (HODGSON) IN HILLY TERRAIN OF MIZORAM[1]

N. S. Chauhan and R. N. Saxena[2]

(*With a plate*)

The males of the field rat, *Rattus rattus brunneusculus* (Hodgson) were collected every month during the period 1976 to 1979 from different areas of Mizoram. Body weight of each rat was noted. The observations were made on the weight and histology of the testes and various accessory sex organs during different months of the year.

The male of this species is a seasonal breeder and shows a single long breeding season from May to October. During this period, the weights of testes and accessory sex organs are high. The testicular histology shows broad seminiferous tubules with sperms and large interstitial cells with vesicular nuclei. The breeding phase is followed and preceded by the short regressive and progressive phases respectively. The non-breeding phase extends from December to February. During these months, there is significant reduction in the testis weight and the seminiferous tubules have germ cells limited to primary spermatocytes. The interstitial cells are inconspicuous and have small often pycnotic nuclei and little cytoplasm. Parallel to the reduction in the testis weight, the accessory sex organs also exhibit a decrease in weight.

Introduction

The field rat, *Rattus rattus brunneusculus* (Hodgson) is commonly found in Mizoram, a Union Territory of India. It usually inhabits crop fields, forests and tribal settlements. It is observed that the population of this rat increases exponentially at the time of bamboo flowering. It inflicts incalculable loss to paddy (*Oryza sativa*) and vegetable crops as well as stored grains thereby resulting in famine conditions. Therefore, this rat is of great economic importance. An attempt has been made to investigate the physiology of reproduction of this rat. The present study deals with the annual reproductive cycle of the male.

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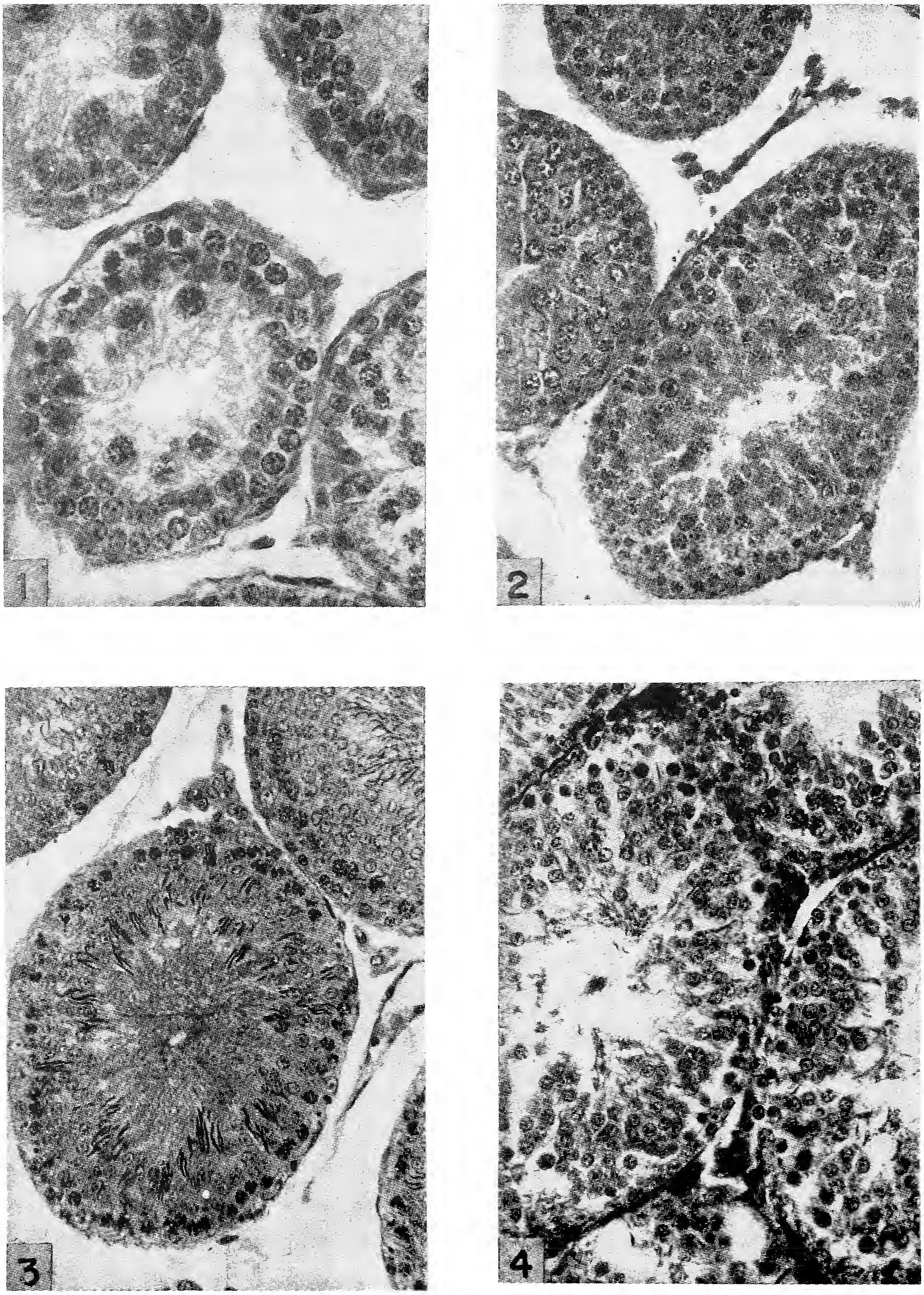
Materials and Methods

More than eight hundred adult males of *Rattus rattus brunneusculus* were collected from crop fields and adjacent forests located in different areas of Mizoram from 1976 to 1979. The animals were either caught alive from their burrows or trapped by using 'Sherman' traps. The animals which had minimum body weight of 45 g and length of 28 cm were taken as adults and used in this study. The animals were autopsied within 10-12 hrs of their capture. The body weight was noted prior to autopsy. The testes, epididymides, prostate glands and seminal vesicles were dissected free of fat and connective tissue and weighed on a precision balance to the nearest 0.2 mg. All the weights given in the tables, wherever applicable, are the mean weights of paired organs.



Photomicrographs of T. S. of testes showing:
Fig. 1. Non-breeding conditions. × 400. Fig. 2. Recrudescence. × 250. Fig. 3. Breeding conditions. × 250. Fig. 4. Regressive changes. × 250.

Only the tissues from representative animals of each month collections were fixed in Bouins fluid for histological study. Sections were cut at 5-7 micra and stained with Haematoxylin and Eosin. The diameter of approximately 15-20 seminiferous tubules and nuclei of 25-30 randomly selected interstitial cells from each testis section was measured by means of an ocular micrometer.

Results

Testis

Weight (Table 1)

The testis showed marked variations in the weight during different months of the year. It was lowest in February, started increasing in March and a significant increase was observed in April ($p<0.001$). It further increased in May and this peak value was almost maintained till October. Thereafter, regression sets in and the weight started decreasing gradually and significant reduction was noted in December ($p<0.001$), reaching lowest once again in February. During non-breeding phase (December to February) the testes become abdominal in position while they descend down into the scrotum during breeding phase (May to October).

Histology (Plate 1 — Figs. 1-4, table 1)

From December to February when testes weights were very low, the histology also showed regressed state. It was characterized by the presence of a thick, fibrous and crumpled tunica albuginea. The seminiferous tubules were narrow, the germ cells were restricted to primary spermatocyte stage and lumen was almost clear (Fig. 1). There was an apparent increase in the number of Sertoli cells. The intertubular spaces were enlarged, the interstitial cells were small with oval and small nuclei and appeared non-secretory. In March and April, with the testis recrudescence, concurrent regenerative changes were seen in its histology. It was characterized by an increase in diameter of seminiferous tubules (Table 1) and even the appearance of spermatozoa in a few tubules indicating reinitiation of the germ cell activity. The interstitial cells also became prominent and showed some secretory activity as was evident by their vesicular nuclei (Fig. 2). At the time when testes weights were very high (May to October) the histology showed perfect breeding characteristics. The tunica albuginea was thin and smooth. Spermatozoa were seen in most of the seminiferous tubules which became more compact in arrangement due to increase in their diameters thereby the intertubular spaces were greatly reduced (Fig. 3). The interstitium was less marked. The interstitial cells were large, polyhedral and with spherical vesicular nuclei. In November, when the testes weights were significantly decreased, the seminiferous tubules were reduced in diameter resulting in an increase in the intertubular spaces. Degenerated spermatozoa, spermatids and even secondary spermatocytes in the form of debris were characteristically observed in the lumen of the tubules. At the advance stages of regression, the tubules were almost cleared off their debris. The interstitium became more visible due to narrowing of the tubules and the interstitial cells became less prominent (Fig. 4).

Accessory sex organs

Weight (Table 2)

The changes in the weight and histology of the accessory sex organs were closely parallel to the testicular cycle. From December to February when the testes were regressed, the weights of different accessory sex organs (epididymis, prostate, seminal vesicle) were lowest and the histology showed non-secretory characteristics. While during the breeding phase (May to October) these organs were maximally grown and appeared to be highly secretory. The details of histology of these organs are being presented elsewhere.

TABLE 1

MONTHLY CHANGES IN TESTIS WEIGHTS (MEAN±S.E.) AND DIAMETER OF SEMINIFEROUS TUBULES AND INTERSTITIAL CELLS OF *R. r. brunneusculus*

Month	Testis		Seminiferous tubules		Interstitial cells	
	Number of animals	(mg/100 g body weight)	Number of tubules measured	Diameter (micron)	Number of cells measured	Nuclear diameter (micron)
January	78 'a'	251± 17.3	27	111.5±12.86	38	4.32±0.085
February	75	139± 14.9	18	100.6±12.76	30	4.92±0.360
March	58 'b'	476± 40.5	26	171.2±16.91	41	5.74±0.121
April	37 'c'	1114±126.0	15	275.0±10.00	25	5.73±0.210
May	50 'd'	2105± 46.5	24	257.5± 3.82	37	5.92±0.374
June	54	2111±130.0	30	296.8±11.75	50	5.94±0.234
July	60	1927±100.0	24	289.6±17.63	40	6.22±0.266
August	102	1834± 67.5	30	296.7±18.33	38	5.82±0.158
September	69	2099± 76.5	32	280.8± 6.51	36	5.98±0.104
October	97	1616±113.0	21	297.5± 7.50	39	5.95±0.161
November	84	1417±160.0	26	222.5±13.50	31	5.13±0.251
December	58 'e'	614± 40.4	35	126.7±10.14	35	4.28±0.192

'p' Values	Testis	Seminiferous tubules	Interstitial cells
	'c' vs 'd' < 0.001	'a' vs 'b' < 0.005	'a' vs 'b' < 0.001
	'd' vs 'e' < 0.001	'b' vs 'd' < 0.001	
		'd' vs 'e' < 0.001	

TABLE 2

MONTHLY CHANGES IN WEIGHT OF EPIDIDYMIS, SEMINAL VESICLE AND PROSTATE OF *R. r. brunneusculus*

Month	Number of animals	Epididymis (mg/100 g body weight)	Seminal vesicle (mg/100 g body weight)	Prostate gland (mg/100 g body weight)
January	78 'a'	28.9± 4.9	12.9± 1.8	30.5± 3.4
February	75	29.1± 4.9	11.9± 2.5	17.2± 6.2
March	58 'b'	166.7± 6.2	32.4± 1.4	122.1± 8.4
April	37	283.1±83.8	134.7±23.1	278.2±57.5
May	50 'c'	404.2±85.9	122.3±25.8	275.4±67.4
June	54	768.8±35.1	188.4±22.9	350.7±41.7
July	60	716.5±34.0	207.4±20.4	409.0±36.7
August	102	662.3±39.3	187.6±23.9	362.3±35.2
September	69	558.6±92.9	188.9±27.1	371.2±62.4
October	97	584.2±66.0	185.5±21.9	318.2±48.8
November	84	436.9±81.8	128.9±17.1	236.8±52.0
December	58 'd'	174.3± 5.2	23.5± 6.6	36.8±16.3

'p' Values	Epididymis	Seminal vesicle	Prostate gland
	'a' vs 'b' < 0.001	'b' vs 'c' < 0.001	'a' vs 'c' < 0.001
	'b' vs 'c' < 0.001	'c' vs 'd' < 0.001	'c' vs 'd' < 0.001
	'c' vs 'd' < 0.001		

Discussion

As revealed by monthly changes in the weight and histology of testes and accessory sex organs, the male of the common field rat, *Rattus rattus brunneusculus* (Hodgson) in Mizoram is a seasonal breeder. The breeding season extends from May to October whereas the non-breeding phase is of a shorter duration (December to February).

Throughout the breeding phase of *R. r. brunneusculus,* the testes remain maximally grown with abundant spermatozoa in their seminiferous tubules. Clusters of interstitial cells with vesicular nuclei are seen in reduced intertubular spaces. Short non-breeding phase (3 months) is characterized by low testis weight, absence of spermatozoa in its seminiferous tubules, germ cells only up to spermatocyte stage and a few small interstitial cells in broadened intertubular spaces. Annual breeding cycle of almost the same pattern was observed in certain other rodents such as *Apodemus sylvaticus* (Asdell 1946) and *Rattus cutchicus cutchicus* (Prakash 1971). Besides these features, the testes also become abdominal during non-breeding phase and descend down into the scrotum during breeding phase. Similar change in testis position has also been reported for *Malacomys longipes* and *Apodemus sylvaticus* (Asdell 1946).

In animals showing regular periodicity in reproductive activity, there exists a close relationship between the absolute number, size and functional activity of the interstitial cells and gametogenic activity. In *Tatera indica cuvierii* (Prasad 1956), *Funambulus pennanti* (Reddy and Prasad 1968) and *Nesokia indica* (Gariyali 1975) the interstitial cells show parallel changes with that of gametogenic activity. Whereas, a reverse condition in which the interstitial cells show increase in size, number and functional activity in regressing or regressed testes, has also been reported in *Myotis griescens* (Miller 1939). In the present rat species, the interstitial cells show changes which run parallel to gametogenic activity. The periodic increase in the number of interstitial cells in sexually active animals may be either due to division of the existing interstitial cells or by transformation of intertubular non-secretory stromal cells into secretory interstitial cells as suggested by Gopalakrishna (1949) and Prasad (1956).

Prior to attainment of perfect breeding or non-breeding characteristics, testes show gradual but marked changes in weight and spermatogenesis. After termination of breeding activity, a decrease in testis weight and degeneration of spermatozoa along with some other types of germ cells occurs. The deposition of degenerated components as debris within the lumen of tubules marks the regressive phase (November). Subsequent clearance of the debris and presence of germ cells only up to spermatocytes leads the animals to non-breeding phase. After non-breeding phase the recrudescence of testes, as marked by increase in their weights and onset of spermatogenesis, begins and culminates into perfect breeding condition. This growth period is called as progressive phase (March-April). Similar progressive and regressive phases have also been identified in *Funambulus pennanti* (Reddy and Prasad 1968). Thus, on the basis of the changes occurring in testes, the annual reproductive cycle of the male of this rat can be divided into breeding (May to October), regressive (November), non-breeding (December to February) and progressive (March-April) phases.

These cyclical changes in the testis may be possibly due to variations in the levels of pituitary gonadotropins. In certain seasonally breeding mammals like ram (Ortavant *et al.* 1964, Pelletier 1973, Katongole *et al.* 1974,

Sanford *et al.* 1974a, b, Gomes and Joyce 1975), snow shoe hare (Davis and Meyer 1973a, b) and white tailed deer (Mirarchi *et al.* 1978) a definite relationship has been shown between testis activity and pituitary gonadotropins. During the breeding phase, the level of pituitary gonadotropins was found to be highest while it was lowest during the non-breeding phase. Recently, Lincoln and Kay (1979) observed increasing circulating levels of LH during growth phase of the testis and consequently testosterone peak was observed coinciding with the active spermatogenesis in the red deer stag. All these observations lead us to speculate that in this rat also, the seasonal increase and decrease in the levels of pituitary gonadotropins may be the primary factor controlling the cyclic changes in the gonadal activity. Besides, various other factors, both intrinsic and extrinsic either independently or jointly, may also be responsible for the regulation of the reproductive cycle.

It may be possible that the regression occurs due to cumulative effect of negative feedback by high levels of sex hormones secreted during the breeding phase because of which the circulating levels of gonadotropins decrease and consequently gradual regression sets in which leads to non-breeding phase. This phase is maintained for a considerable duration either because of non-stimulatory levels of gonadotropins or occurrence of a refractory period following the breeding phase as reported in most of the seasonally breeding animals (Reiter 1972, Turek *et al.* 1975, Sansum and King 1975, 1976, Murton and Westwood 1977, Grocock 1980, Zucker *et al.* 1980, Soares and Hoffmann 1982). It is during this period that hypothalamo-hypophyseal-gonadal axis or any one of its components becomes unresponsive to a stimulus. However, when the levels of gonadotropins start increasing possibly due to positive feedback effect of low levels of sex hormones from regressed testes or when the refractoriness is over, the gonads once again show recrudescence and the animals get into progressive phase.

The increase and decrease in the weight and functional activity, as judged by histological studies, of various accessory sex organs are seen to be closely related with the testicular cycle. The interstitial cells are known to be the principal source of androgens which control the growth and functional activity of the accessory organs. Seasonal variations in the androgen synthesis and release by these cells, associated with the testis cycle are reflected in a series of changes in the accessory organs. During the breeding phase when the testes show maximum gametogenic activity and the interstitial cells are conspicuous, large and active, the accessory sex organs show maximum weights and functional activity. At the termination of breeding phase, a gradual regression of the accessory sex organs occurs following regression of the testes which ultimately leads to regressed state of these organs in December, the beginning of non-breeding phase. The recrudescence of testis is accompanied by increase in weight and reinitiation of functional activity of the accessory sex organs. Such cyclical changes in the accessory sex organs related with testicular cycle are also reported in other seasonally breeding mammals (Wislocki 1949, Mossman *et al.* 1955, Short and Mann 1965, Reddi and Prasad 1968, Ellis and Balph 1976, Lincoln and Kay 1979). The high levels of androgens during the breeding phase seem to be responsible for the maximum growth and functional activity of the accessory sex organs. Whereas, the reverse may be for the non-breeding phase. Our results can be explained on the basis of the work of Lindner (1963) which shows differences in the concentration of androgen between the lymph and blood of the testis in

ram. The testosterone concentration during the testicular growth phase in the lymph was higher than that in systematic blood plasma. It is likely that in this rat, during recrudescence the testosterone concentration maintained by testicular lymph is adequate only for gametogenic activity but its concentration in the blood plasma is below the threshold level required for the accessory sex organs functions. Subsequent increase in the androgen level in blood plasma may initiate and maintain the accessory organs activity.

Acknowledgements

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STUDIES ON *ANOPHELES* (*CELLIA*) *MACULATUS* THEOBALD, 1901 IN BASTAR DISTRICT, INDIA (DIPTERA : CULICIDAE)[1]

ZAKIR HUSAIN HUSAINY[2]

(*With five text-figures*)

A total of 168 specimens of *Anopheles maculatus* were collected in 12 villages of Bastar District, Madhya Pradesh, India, out of 105 surveyed in 1206 man-hours. This mosquito was not found either in cattle-sheds or human dwellings in the day. A uniform feeding pattern was not seen all round the year. This species of *Anopheles* appeared to be more numerous in rainy season and to be more abundant in the forests of the Hot-moist climatic region with an elevation of 609 to 761 m. The anopheline was not captured from the human bait. None of the females dissected showed gut or gland infection by malarial parasites.

INTRODUCTION

The oriental element *Anopheles maculatus* has so far been recorded from Afghanistan (Ward 1972); Pakistan, Bangladesh (Aslamkhan 1971); Nepal (Brydon *et al.* 1961); Sri Lanka (Harrison *et al.* 1974); Burma (Khin Maung-Kyi 1971); China (Chow 1949); Hongkong (Pal and Sharma 1955); Taiwan (TAMRI and W.H.O. 1958); Thailand (Peyton & Scanlon 1966); Cambodia (Harrison and Klein 1975); Vietnam (Stojanovich and Scott 1966); Philippines Islands (Baisas 1974), Malaysia (Reid 1968) and Indonesia (Van Hell 1952) (Fig. 1). This mosquito is the most important vector of malaria in the interior of Malaysia (McArthur 1950), Philippines, Indonesia, Vietnam (Dy 1954); Yunnan and Hongkong (Pal & Sharma 1955). It does not appear to be a vector of malaria in Thailand (Scanlon *et al.* 1968). In India it is of no vectorial importance whatever, save in Shillong town in the Khasia Hills of Assam (Senior White 1948). Its present distribution in India has been summarised by Puri (1955) (Fig. 2).

The Bastar District has been reported as hyper-endemic for malaria and *Anopheles culicifacies* Giles and *Anopheles fluviatilis* James were considered as the primary vectors (Vaid & Nagendra 1964). Despite all precautionary measures, the district still continues to be in the attack phase of the present nationwide malaria eradication programme which was started in 1959. Studies were, therefore, carried out to determine the epidemiological significance and bionomics of the anopheline fauna of the area. In this communication, findings on *Anopheles maculatus* Theobald have been described and discussed.

AREA AND CLIMATE

Bastar District lies roughly in the central part of India and extends from 17°46′N to 20°34′N latitude and from 80°15′E to 82°1′E longitude (Fig. 2). It has an area of 39,086 sq. km containing 3154 villages and three towns which fall into five main physiographi-

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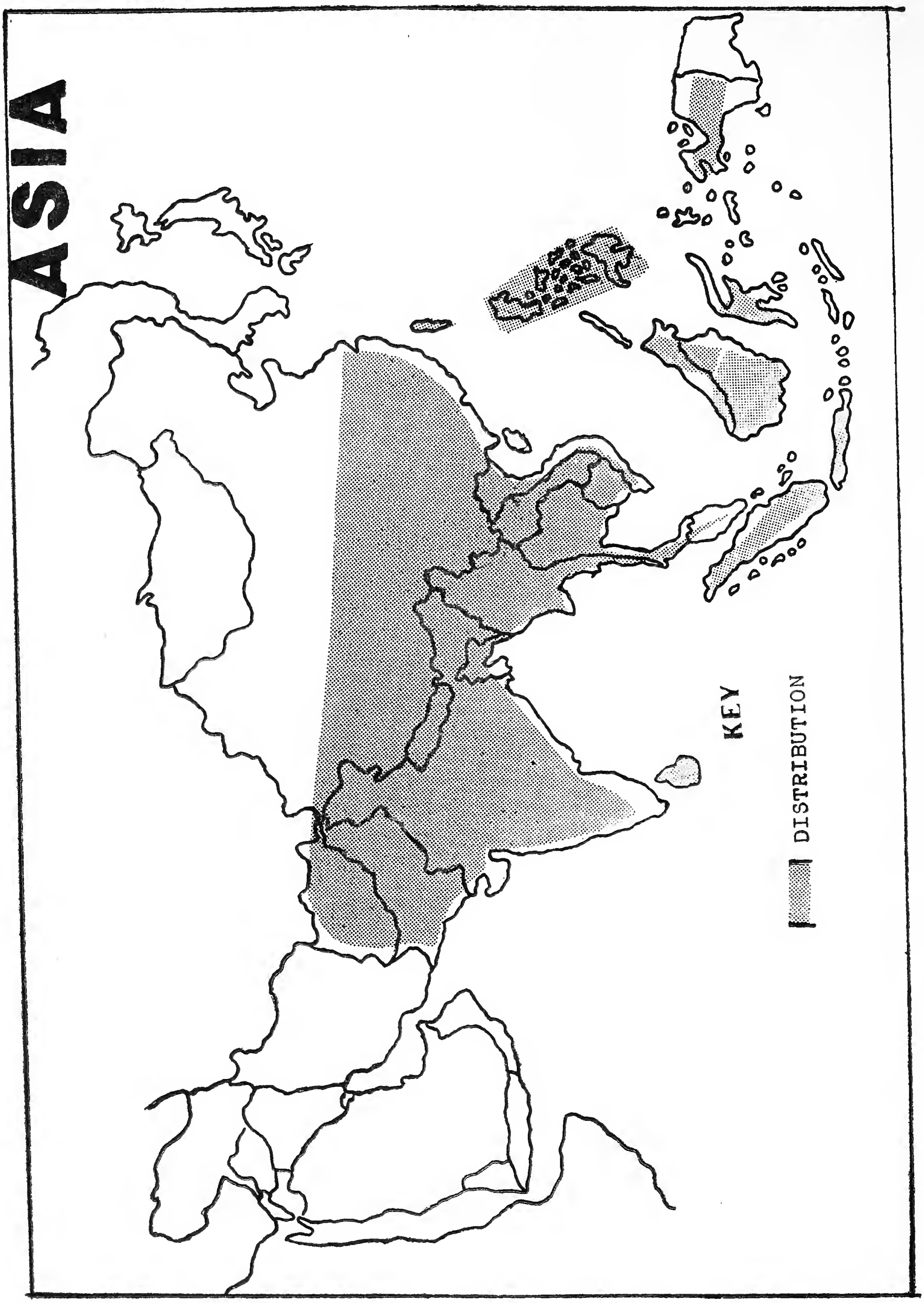

Fig. 1. Map of the Oriental region showing countries where *Anopheles maculatus* has so far been recorded.

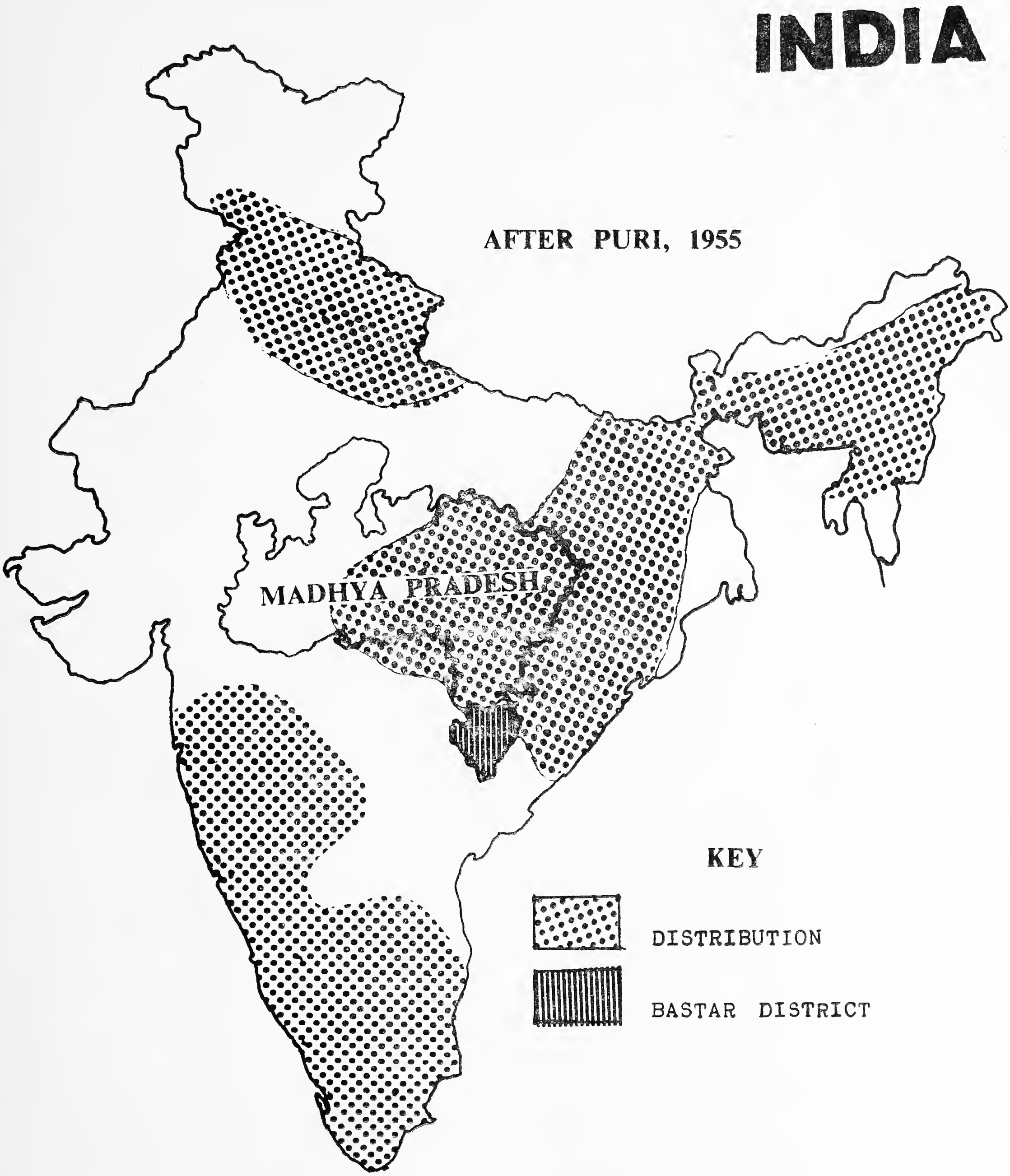

Fig. 2. Map of India showing distribution of *Anopheles maculatus*.

cal divisions (Fig. 3). Almost 70 percent (22,169 sq. km) of the area is covered with forests. The altitude ranges from 48.5 m (village Konta) to about 1275.5 m (village Bailadila) (Agarwal 1968). This district shares a monsoon type of climate with the general Indian landmass, although the diversity of its relief does not encourage a uniform climate. The period from March to mid-June embraces dry early summer while from mid-June to October it is wet late summer. The winter season is from November to February while the period from June to October covers the general rainy season. There are three distinct mean temperature divisions, *viz.* 22 to 24°C, 24 to 27°C and 27 to 29°C. There may be two annual rainfall divisions, e.g. 152 to 178 cm and 127 to 152 cm. With three temperature and two rainfall divisions, the district is divisible into five climatic regions (Fig. 4). The villages consist of several hamlets called *paras* each with a few hutments situated at some distance from one another. The area is sparsely populated. Every family residing in the village generally keeps such domestic animals as cow, goat, pig, dog, and poultry. Most of these are accommodated in rickety cattlesheds.

Material and Methods

Mosquitoes were caught by day and night time, through general and routine collections made inside human dwellings and cattlesheds of selected villages. Collections were also made by the Pyrethrum spray technique inside human dwellings to detect mosquitoes resting there. Outdoor collections were made in early morning hours in the area between the nearest potential larval habitat and human dwellings. A pit shelter was made in village Bispur under a tree in a rice field located in between a pond and a house. Its size was 2 m × 1 m × 2 m deep. Two pits each of $\frac{1}{2}$ m × $\frac{1}{2}$ m × $\frac{1}{2}$ m deep were excavated on each wall of the pit and a ladder was placed on one side of the pit. A roof of matting was laid on this pit leaving a gap at the side of the ladder for entrance. Collections were made in this pit for 15 minutes every morning. In order to determine feeding times and seasonal prevalence, all night collections were made between 1800 and 0600 hr at intervals of two hours for half an hour each time. The first collections were always made at the time of sunset in different months which normally occurred between 1800 and 1900 hrs while other collections of the night were made at fixed hours all round the year. In every night of work seven man-hours were spent on the collection. Man-biting rates were determined by placing a man as a bait and another collecting mosquitoes actually feeding this bait since landing rates do not always indicate biting. In all these campaigns, only anopheline mosquitoes were collected by an aspirator in the torch light and were identified at the end of collection time on the spot in either sun or bright petromax light and their species, abdominal conditions and time and site of captures were noted. The females were dissected to determine parity status and sporozoite infection.

Observations

These studies were conducted between October 1968 and January 1975. In this duration 21,716 specimens of 19 species of *Anopheles* were collected in 1206 man-hours from 105 villages which had 168 specimens of *Anopheles maculatus* taken from 12 villages as follows. The number of specimens collected from each village is given within brackets, while the name of each village is preceded by a numeral which marks its location on Fig. 3.

Specimens collected. (1) Ban Usri (1); (2) Bispur (11); (3) Burdum (5); (4) Darbha (114); (5) Gawadi (2); (6) Jagargunda (2); (7) Kamanar

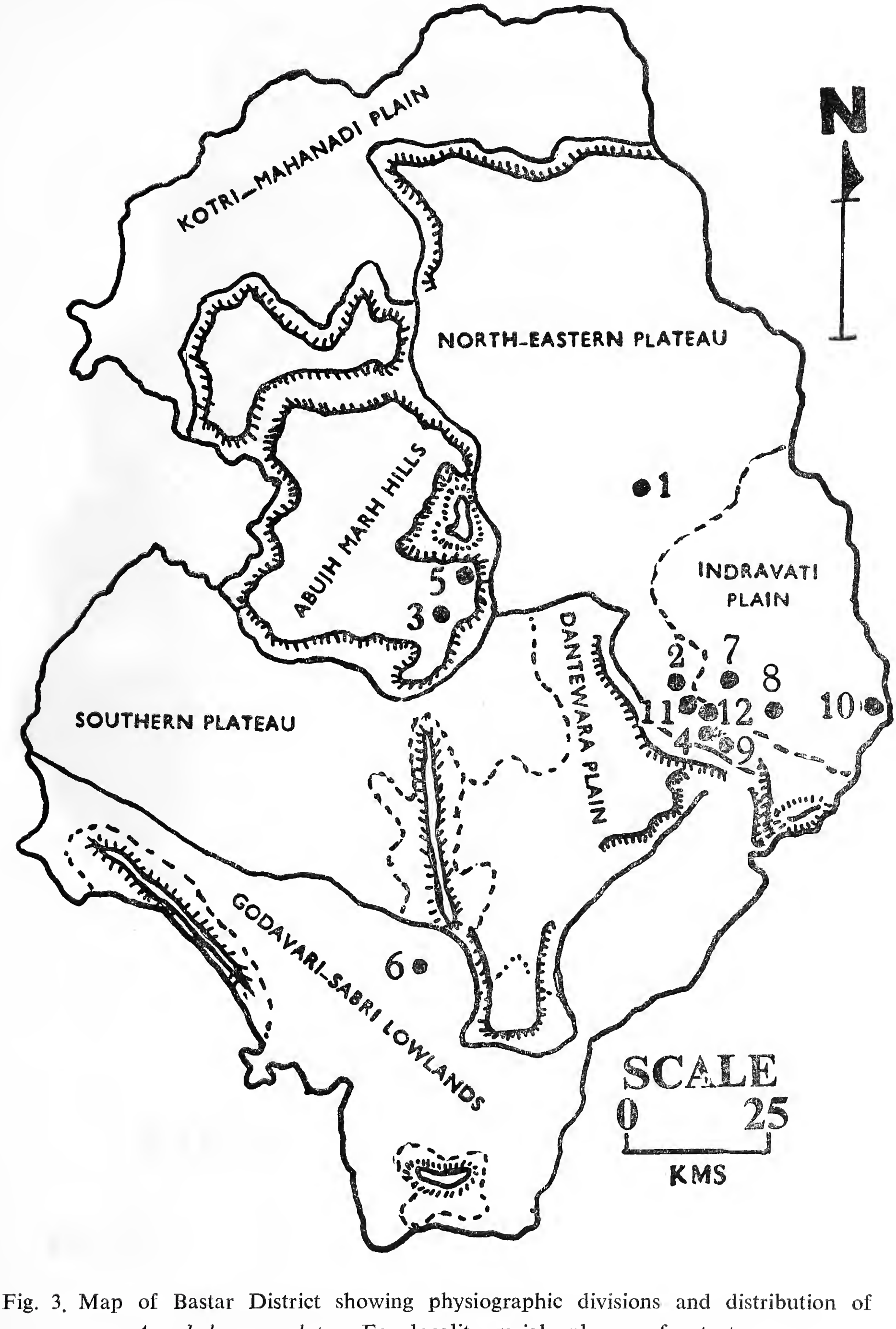

Fig. 3. Map of Bastar District showing physiographic divisions and distribution of *Anopheles maculatus*. For locality serials please refer text.

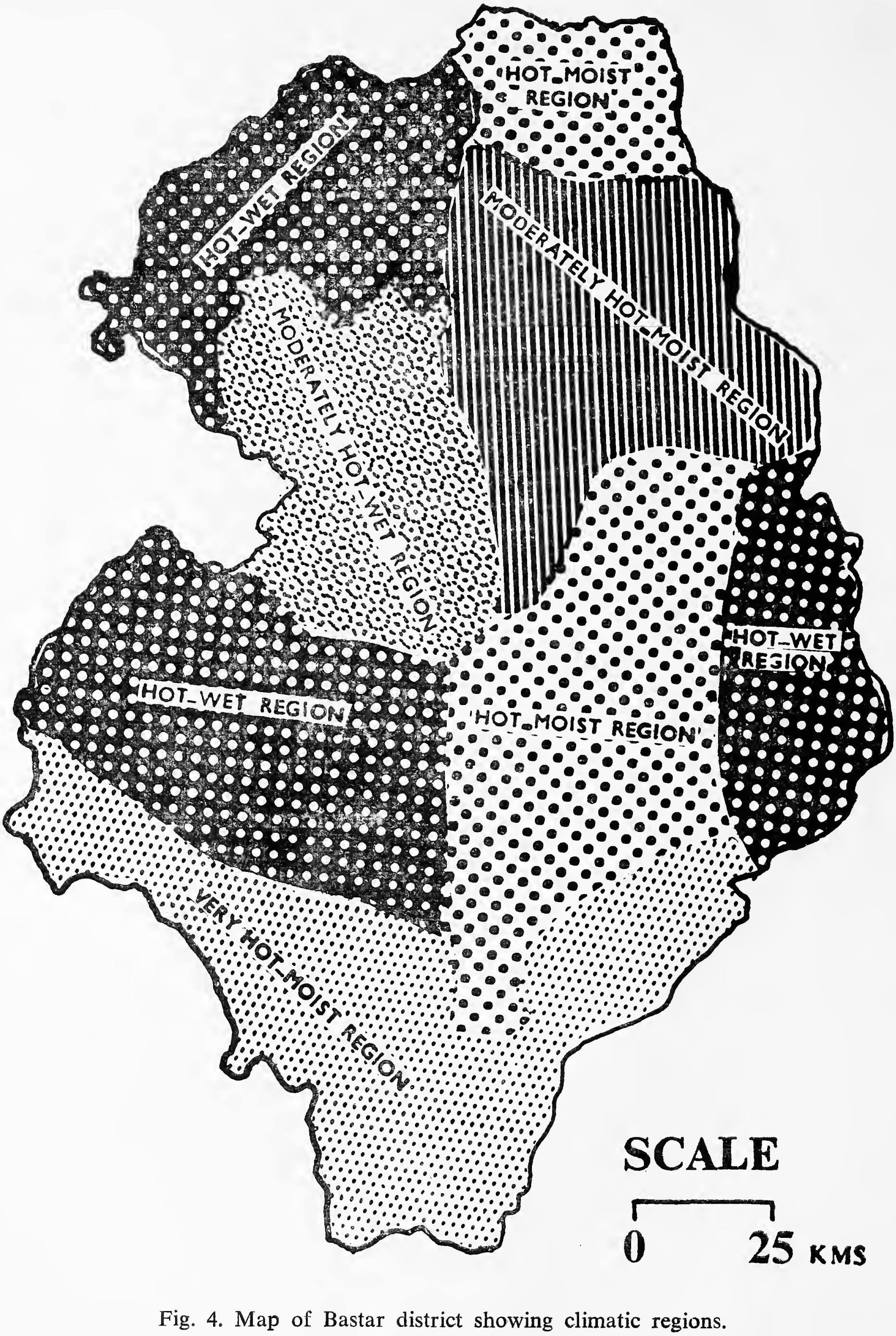

Fig. 4. Map of Bastar district showing climatic regions.

(9); (8) Kotamsar (7); (9) Kukalgur (9); (10) Machkot (1); (11) Mamadpal (4); (12) Tirathgarh (3): Total 168.

Distribution. This species has been recorded from the North-eastern plateau, Abujh Marh Hills, Indravati Plains, and Godavari-Sabri Lowlands. It has been secured at an elevation from 152 to 761 m and moderately hot-wet, hot-wet, hot-moist and very hot--moist climatic regions of the district.

Diurnal resting places. In Table 1 are displayed the collection of this mosquito in various habitats. It may be seen that in human dwellings this species was not encountered either in the day or in the night. On bamboo fencings, roofs and wooden pillars of the rickety cattlesheds, 161 females were taken in the night. Among these 24 females were unfed and 143 were fed while one was part gravid. Outdoors, from 0600 to 1800 hrs seven freshly fed females were secured from such sites as bushes, tall grasses, and other such vegetation in between the houses and potential larval habitats.

Feeding times of female adults. In the forest village of Darbha 78 routine all night collections were made to determine the biting times of anopheline mosquitoes. In these catches which were made between August 1969 and October 1974, 132 freshly fed females of this species were taken in the rickety cattlesheds at different hours of the night. In Fig. 5 are displayed the biting cycles prepared from the combined data of the collections of different hours of respective months.

The longest feeding periods were noted in September and October while shortest in December and January. In September this species was taken in increasing numbers after dark peaking at 2230 hrs and declining progressively through the night. In the winter season from October to February the peak of feeding activities were noted immediately after sunset while in summer season, the peak occurred at 2230 hrs declining abruptly thereafter. In the rainy season most of the feeding was completed before mid-night. In summary, 98 freshly fed females were taken before mid-night while 34 after mid-night.

Density buildup. Between October 1969 and September 1970, a total of 36 all night regular captures were made to determine the density buildup of *Anopheles maculatus* at village Darbha which had the hot-moist climate. In this campaign of 252 hrs, 2866 specimens of 18 species of *Anopheles* were captured of which 66 were females of *Anopheles maculatus* (Table 2). It was revealed that 32 specimens, forming 48.3 percent were secured in the rainy season (June to August). The peak of density was noted in July. In other seasons it was found less numerous.

Seasonal prevalence. The monthly captures of *Anopheles maculatus* in other villages are shown in Table 2. Although this mosquito was taken all round the year, 54 specimens forming 52.9 percent were secured in rainy season (June to August). In the peak of winter (December-January) and the summer (May) this *Anopheles* was less numerous. The density build up pattern appeared to confirm the general seasonal composition of this anopheline in this area.

Area of abundance. In Table 3 the collection of *Anopheles maculatus* in respective climatic belts of Bastar District have been displayed. In the hot-moist belt, where 142 specimens forming 84.5 percent of total captures were encountered, annual rainfall from 127 to 152 cm and mean temperature from 24 to 27°C are recorded. In moderately hot-moist and very hot-moist regions which are the coolest and hottest parts respectively, this mosquito was found as least numerous. It was not taken in the plain area villages. The peak density was noted in a forest village of Darbha

TABLE 1

COMPOSITION OF *Anopheles maculatus* CAPTURED AT VARIOUS SITES IN BASTAR DISTRICT, M.P., INDIA

No.	Habitat and time of collection	Man-hour spent	Numbers collected: Male	Numbers collected: Female	Percent
	Cattlesheds				
1.	A. From 0500 to 1800 hrs	144	0	0	—
	B. From 1800 to 0500 hrs	819	0	161	95.9
	Human dwellings				
2.	A. From 0500 to 1800 hrs	58	0	0	—
	B. From 1800 to 0500 hrs	81	0	0	—
	Outdoors				
	From 0600 to 1800 hrs	104	0	7	4.1
	Total	1206	0	168	100

TABLE 2

SEASONAL PREVALENCE OF *Anopheles maculatus* AT DIFFERENT PLACES

Area	Numbers collected at: Bastar District M.P. India		Nilgiris, Tamil Nadu, India: East	Nilgiris, Tamil Nadu, India: West	Jalan Kayu Singapore
Months / Source	Present studies		Russell and Jacob (1942)		Chan (1969)
	Density build up in Darbha Actuals collected	Seasonal composition in other villages Actuals collected	Per-man hour	Per-man hour	Per-man hour
January	0	3	0.4	—	—
February	2	2	0.2	1.1	—
March	0	5	9.1	0.4	0.70
April	0	6	0.2	0.7	0.74
May	8	2	0.1	—	0.12
June	9	7	—	0.1	0.00
July	16	27	0.1	0.1	0.00
August	7	20	—	0.4	0.10
September	9	13	0.2	0.3	0.00
October	8	5	—	0.3	—
November	7	9	—	—	—
December	0	3	0.1	0.1	—
Total	66	102			

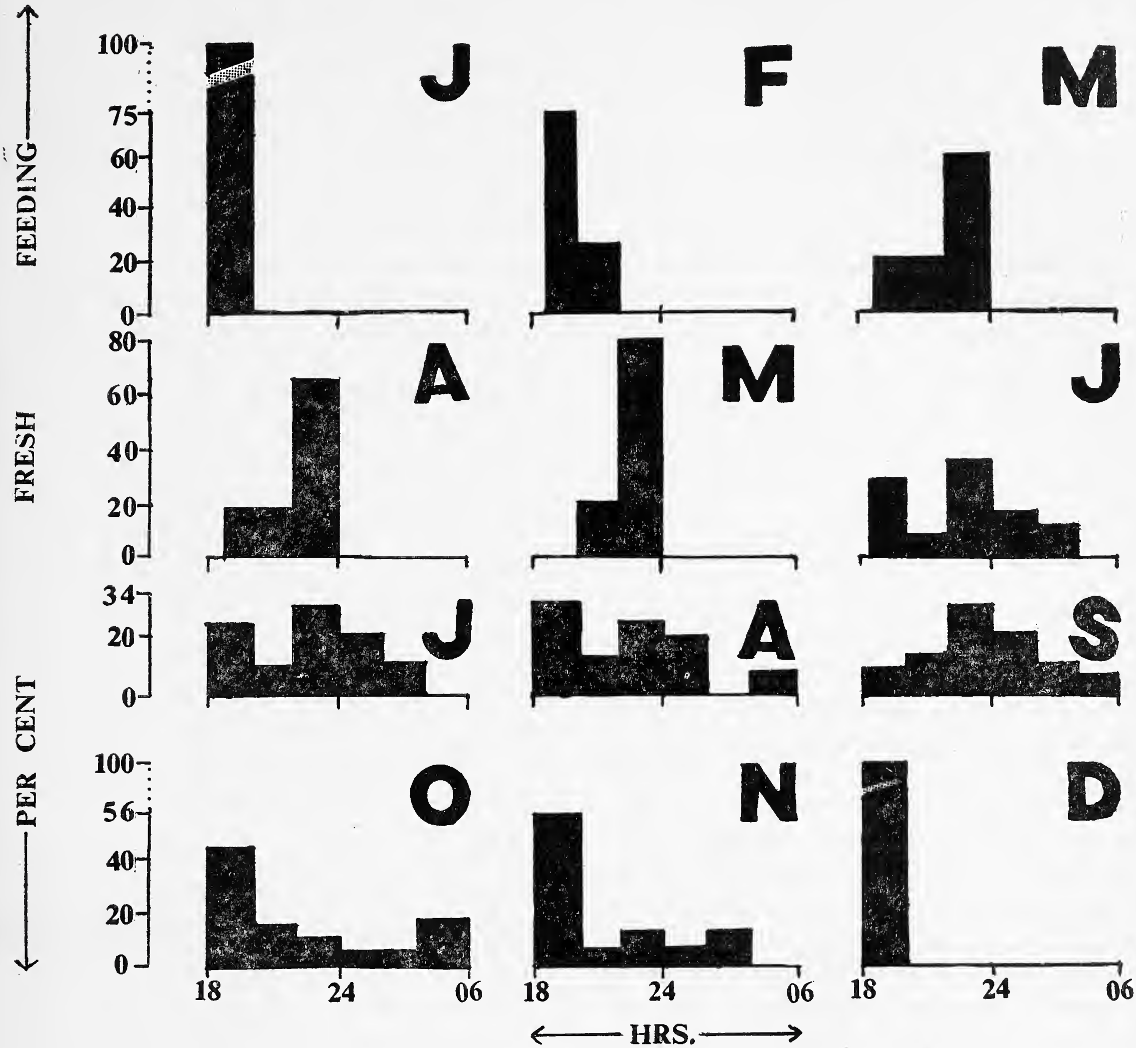

Fig. 5. Feeding times of *Anopheles maculatus* female adults at village Darbha, Bastar District.

of the North-Eastern Plateau with elevation between 609 and 761 m.

Man-biting rate. This mosquito was not obtained from human baits placed inside houses during a total of 80 man-hours spent in the determination of man-biting rate, although 330 females (67 anopheline, 263 culicine) were taken in three villages in these campaigns.

Dissections. Out of a total of 133 females dissected, 92 were nulliparous. Sacs were seen in 8 and retained eggs were found in 7 females (1 unfed, 6 fed). Six of the remainder (41) had two dilatations and one had three. The dissection data are given in the Table 4. None of the specimens dissected showed gut or gland infection for malarial parasites. Mites were recovered from 25 (8 unfed, 17 fed) females.

TABLE 3

COLLECTION OF *Anopheles maculatus* IN DIFFERENT CLIMATIC REGIONS OF BASTAR DISTRICT, MADHYA PRADESH, INDIA

No.	Climatic Region	Nos. collected	Percent
1.	Moderately hot-moist region	—	—
2.	Moderately hot-wet region	7	4.0
3.	Hot-wet region	17	10.5
4.	Hot-moist region	142	84.5
5.	Very hot-moist region	2	1.0
	Total	168	100.0

DISCUSSION

Anopheles maculatus was noted as a rare species in the anopheline fauna of the Bastar District, as it occupied only 0.07 percent in the total collection. Srivastava (1950) reported that at Kichha, Nainital District, his anopheline collection had 0.7 percent of this mosquito. In Afghanistan, Rao (1951) found only two specimens of *Anopheles maculatus* in his collection of 6,242 individuals of 13 species of *Anopheles.* This insect comprised only 1.49 and 0.09 percent in two surveys made in 1965 in South Andamans although in the first survey of Middle and North Andamans, this *Anopheles* was 38.01 and 10.16 per cent respectively of total collection (Krishnan and Halernkar 1967). Srivastava and Diwan Chand (1951) had 6.2 percent *Anopheles maculatus* in their collection of *Anopheles* of Sarda Canal, Nainital District. Contrary to these findings, Khan (1942) found 1725 specimens of *Anopheles maculatus* (almost 50 percent) in his collection comprising 3487 individuals of 12 anopheline species taken in Darjeeling. The elevation of distribution of this mosquito ranged between 152 and 761 m, however, Scanlon and Esah (1965) reported that this species was encountered between 305 and 1830 m in Thailand.

This mosquito appeared to visit cattlesheds during the night while diurnally it took asylum out of doors. Bütticker (1958) described this behaviour as a complete deliberate type "A" exophily (endophagy of Senior White). Christophers (1933) stated that *Anopheles maculatus* is commonly taken in houses and cattle sheds in certain areas. Krishnan and Halernkar (1967) collected *Anopheles maculatus* in cattlesheds at night only in the Andamans islands. In west Nilgiris, Russell and Jacob (1942) took 38 specimens in houses, one in mixed dwellings and 37 in cattlesheds while in the same habitats of east Nilgiris, they secured 6, 2 and 9 individuals respectively. Pal and Sharma (1955) stated that adults of this species are found in houses, cattlesheds and outdoor resting places during the day. McArthur (1950) reported that this *Anopheles* was never found resting in houses. However, Misra (1956) collected *Anopheles maculatus* from human dwellings in North East Frontier Agency.

The feeding times were not uniform in different months. Pal and Sharma (1955) reported that this mosquito bites man between 2100 and 0200 hrs although apparently the feeding habits of this species differs in different regions.

Anopheles maculatus appeared to be mainly a rainy season species although it was taken throughout the year. In Table 2 are indicated monthly collection of this mosquito at Nilgiris District, India and at Jalan Kayu, Singapore. It may be seen that in West Nilgiris, Madras State, Russell and Jacob (1942) collected this insect all round the year with the peak of numerical abundance in February while in East Nilgiris, this *Anopheles* virtually remained absent in June, August, October and in November, Chan (1969) noted peak of den-

TABLE 4

PHYSIOLOGICAL AGE OF FEMALE *Anopheles maculatus* COLLECTED IN THE CATTLESHEDS OF BASTAR DISTRICT, M.P., INDIA

Site of collection	Abdominal Conditions	Numbers dissected	Condition of ovarioles							Numbers positive Gut/glands	Numbers infected with Ecto-parasite (miles)
			Nulliparous	Sacs	Retained eggs	Dilatation					
						1	2	3	4		
Cattle sheds	Unfed	20	13	1	1	4	2	–	0	00/00	8
	Fed	112	79	7	6	21	4	1	0	00/00	17
	Part Gravid	1	–	–	–	–	–	–	–	00/00	–
	Total	133	92	8	7	25	6	1	0		25

sity in March/April while virtual absence in June/July.

From human baits placed in houses, this species was not encountered in the present studies. McArthur (1950) stated that in Tambunan, Indonesia, it was rarely found attempting to feed on man and using the human bait trap, only one specimen was taken on an average every three weeks of all night trapping, although in the presence of hyperendemic malaria. Moussa and Nawarat (1969) collected blood fed females while biting man at Kao Mai Kaeo, Chon Buri Province, Thailand during February, 1967.

Sporozoite infection was not found in any female dissected. Such infection from India has rarely been reported so far. Anderson and Viswanathan (1941) dissected 8483 females of *Anopheles maculatus* and encountered oocyst infection on the guts of 24 females and sporozoites in only five females in Assam during 1931-41. Viswanathan *et al.,* (1941) noted oocyst in 13 females and sporozoites in one female in 1573 dissections of this mosquito collected in the State of Assam in 1940-41.

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ON SOME INSECT GALLS ON *TECTONA GRANDIS* LINN. FROM INDIA[1]

P. JAYARAMAN[2]

(*With seven text-figures*)

Anatomical investigations are made on three foliar galls and one shoot-axis gall on *Tectona grandis* Linn. caused by different gall-midges. Two of the foliar galls are reported for the first time. The stem gall is a lateral outgrowth of rinden-gall type. Several larval cavities occur in the vicinity of the cambial zone and cause distortion of that part of the cambium nearest the larvae. The gall grows due to proliferation of the cortical tissues. The foliar galls are circular, discoid and lenticular with a central short stalk. Anatomically these three foliar galls exhibit subtle differences, while the trichomes occurring on the gall surface differ quite considerably. The same tissues of the host plant respond differently to the different species of the gall-midges indicating that the host tissues have different latent morphogenetic potentials and the cecidozoa are specific to invoke the expression of a particular potential.

This paper deals with four insect galls on *Tectona grandis* Linn. collected by Prof. M. S. Mani and the author near Trivandrum during May, 1980. Three of these galls arise on leaf and one on the branch axis; two of the leaf galls are new. The galls appear about the same time and are nearly all equally abundant. Brief descriptions, with notes on the anatomical characters and mode of development of these galls are given below. The galls are identified by characteristic numbers, which are continuation of the system given by Mani in his PLANT GALLS OF INDIA (1973).

A. SHOOT AXIS GALL

Gall No. 280 by *Asphondylia tectonae* Mani (Mani 1948, 1959, 1973)

This gall was listed as early as 1899 by Stebbing, erroneously as a 'Cynipid' gall and the error was continued by Sundar Raman in 1924. It was first correctly recognized as a midge-gall by Mani in 1948 (op. cit.), who later described the midge reared from the gall in Top Slip (Anamalai Hills) by Dr Sen-Sharma. The gall seems to be widely distributed along the Western Ghats and parts of the Vindhya-Satpura, where teak forests occur. The following anatomical notes form a supplement to the general description of the gall by Mani (op. cit.).

The normal young stem of *Tectona grandis* is typically four-angled and has a narrow periderm, followed by indistinct cortex. The vascular cylinder approximates to the general quadrate outline of the stem section (Fig. 1). The secondary wood is diffuseporous with narrow rays. Two or three concentric narrow bands of libriform fibres occur in the region of secondary phloem. The secondary xylem is composed of vessels with simple perforations and pitted lateral walls (Fig. 2-A) and short, wide-lumened fibres (Fig. 2-B). The parenchyma cells containing crystals also occur in the secondary xylem.

The gall arises as a lateral outgrowth of cortex. The larva seems at first to penetrate in between the secondary xylem and the cam-

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bium. The part of the cambial zone nearest the larva grows out into several distorted strands that later come to be embedded in the gall tissues (Fig. 1). The remote side of the stem develops practically normally.

In a transverse section of the gall the outermost region consists of periderm, which is slightly thicker than in the normal stem. Beneath this lies a broad zone of parenchyma, mixed with an abundance of brachy-sclereids (Fig. 2-C). Inside of this peripheral zone there are several larval cavities scattered at different levels radially about the cortex of the axis. Each larval cavity is elliptical (Fig. 1), surrounded by broad zones of concentric parenchyma cells (Fig. 2-D). The innermost layer of cells lining the cavity are collapsed. The vascular strands in the parenchyma zone consist of tracheary elements with reticulate lateral wall thickenings (Fig. 2-E) and all converge toward the larval cavities (Fig. 1).

B. FOLIAR GALLS

The normal leaf consists of an even layer of thickly cuticularised, rectangular adaxial epidermal cells (Fig. 3-A). The abaxial epidermis is rugose and consists of small cubical cells with the stomata on the ridges. Uni- or multicellular, uniseriate, unbranched, acute hairs and stalked glandular trichomes with multicellular spherical head are copious on the lower surface (Fig. 3-B). The short thick unicellular acute hairs, with heavily cuticularised walls account for the general roughness of the upperside of the blade. The mesophyll consists of two layers of elongate narrow palisade cells. The cells of the first row are longer than those of the second row. The spongy parenchyma has two or three layers of irregular cells. The vascular bundles occur in the spongy mesophyll and the major veins have parenchymatous bundle sheath with adaxial and abaxial extensions.

Gall No. 414 by Gall-midge (Mani 1953, 1959, 1967, 1973).

Hypophyllous or epiphyllous, circular, discoid lenticular gall, about 3 mm in diameter and 1 mm in thickness, inserted on the blade by a narrow, short, central stalk. The first visible indication of the development of gall is a cushion of hairs, which grow denser and turn thickly villous on the mature gall. Transection of the early gall is flat and lenticular, with a small adaxial conical projection and a wide abaxial covering-growth over a shallow larval chamber (Fig. 4-A). The larval cavity opens to the outside by a large ostiole through a narrow passage, lined by straight, short, thick-walled hairs directed outward to the ostiole. The abaxial surface of the gall is clothed with soft, multicellular, dichotomously branched hairs, while the adaxial surface remains almost glabrous. In the transverse section of a young gall three tissue zones are recognised : (1) the adaxial epidermis and its periclinal derivatives alligned in vertical files; (2) a bowl-shaped meristematic zone, around the larval cavity, consisting of small cells with dense cytoplasm and prominent giant nuclei; and (3) an intermediate zone between these two, with the cells vertically elongated and vacuolated. A narrow two-celled layer, at the junction of the vacuolated and meristematic zones below the larval chamber, soon differentiates into sclereids (Fig. 4 A-C). At a later stage, arises lignification of the cells bordering the ostiole and the larval chamber, and vacuolation of the cells around the ostiole, thus delimiting the meristematic zone in the form of hollow circular disc around the larval chamber (Fig. 4-A). The cells of the meristematic zone divide in the anticlinal plane and the derivatives expand radially so that the gall becomes disc-shaped.

On maturation of the gall the meristematic zone turns into a dark tissue, around the small larval cavity and extends down below as a

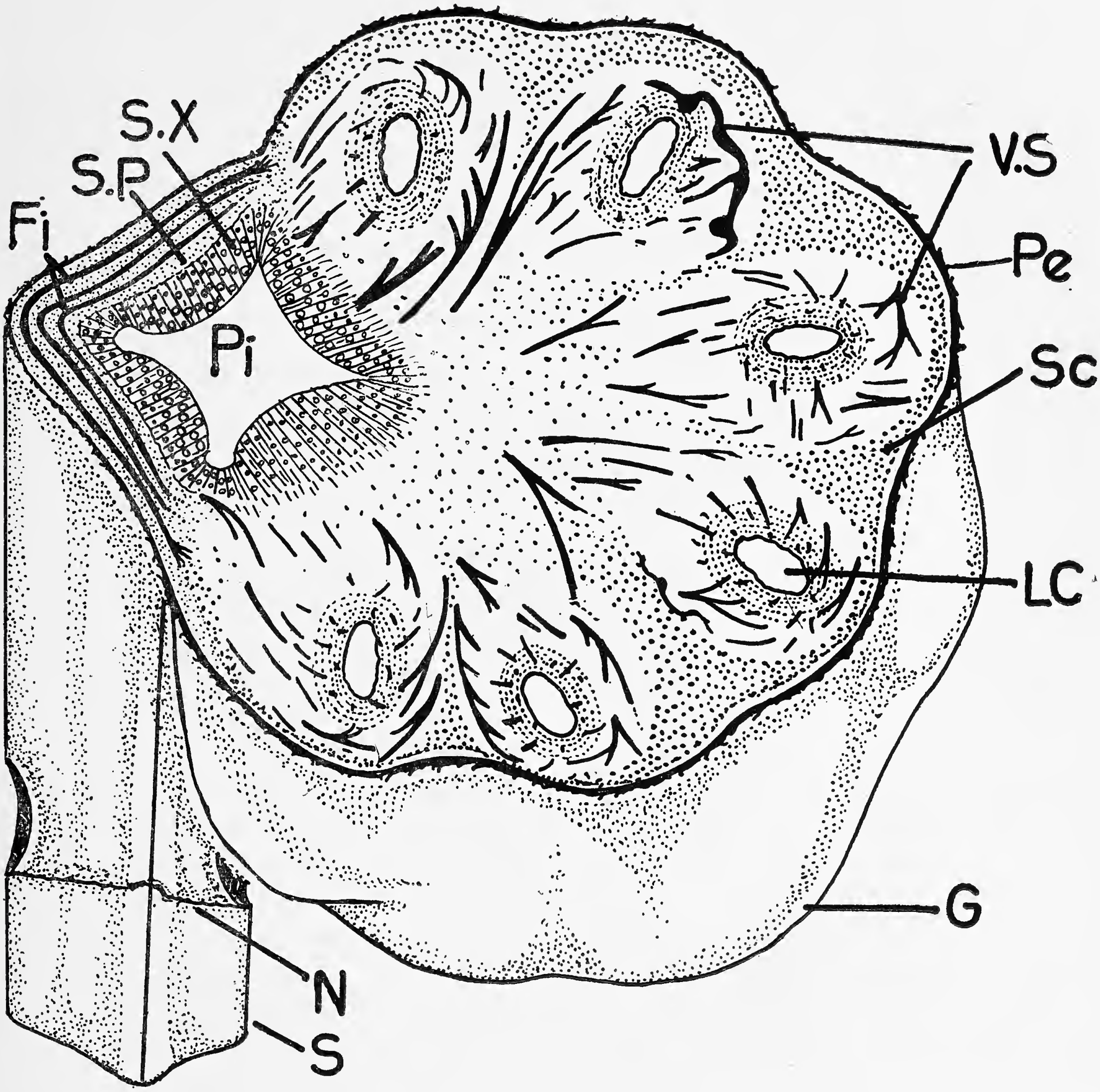

Fig. 1. *Tectona grandis* Linn. Gall No. 280
Stereoscopic diagram of the shoot axis gall caused by *Asphondylia tectonae* Mani. (Fi—Fibres; G—Gall; LC—Larval Cavity; N—Node; Pe—Periderm; Pi—Pith; S—Stem; Sc—Sclereids; S. P—Secondary Phloem; S. X—Secondary Xylem; V. S—Vascular Strands.)

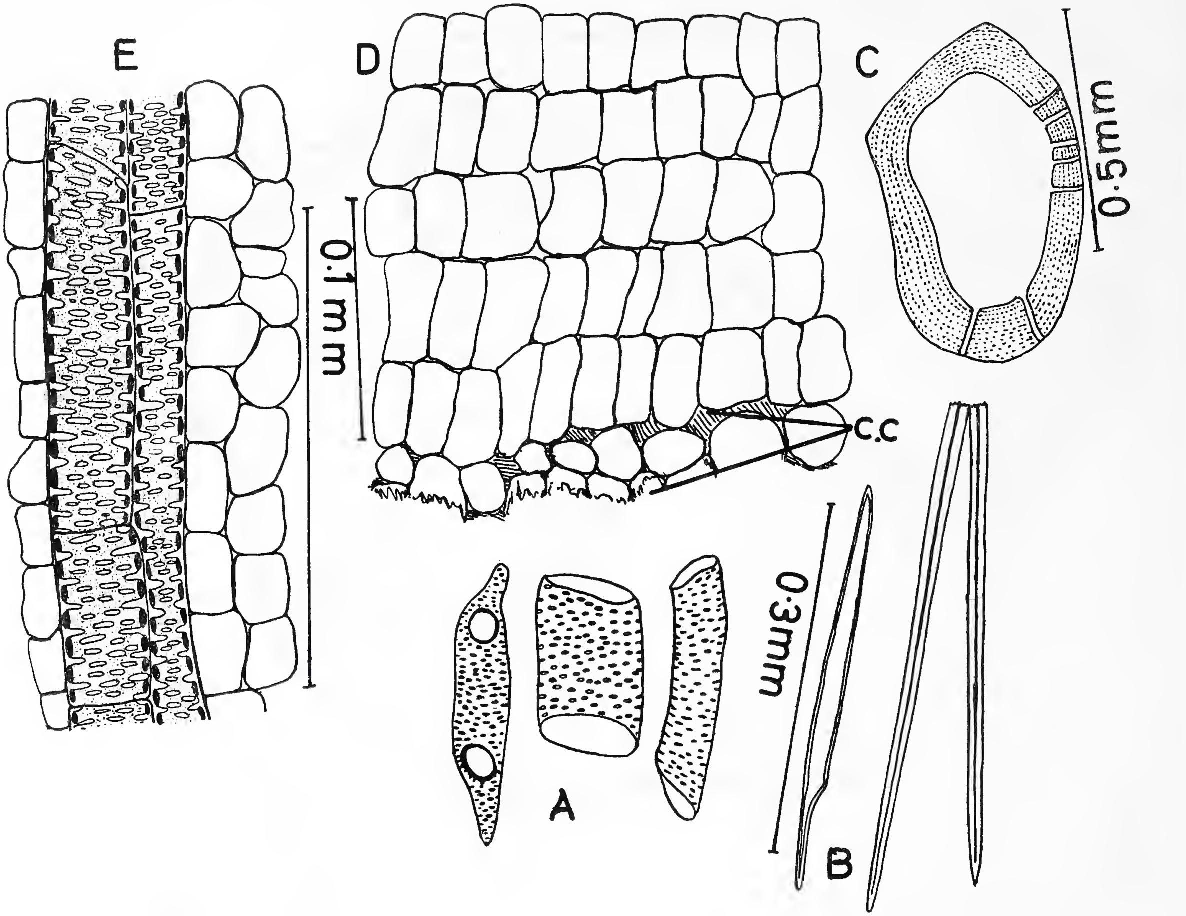

Fig. 2. *Tectona grandis* Linn. Shoot-axis Gall.
A. Vessel elements of normal stem; B. Xylem and cortical fibres of the normal stem; C. Brachysclereid of the gall; D. Storied arrangement of the cells around the larval cavity; E. Lateral wall thickenings of the tracheary elements of the vascular strands in the gall. (C.C—Collapsed cells around the larval cavity.)

thick pillar axially in the middle of the stalk of the gall (Figs. 5-A, B). Two or three layers of cells on the boundary of the dark zone differentiate into sclerotic zone. Clusters of prismatic crystals occur in the cells of the dark zone and in the lumen of the sclereids. Outer to the sclerotic zone is the compact, thin-walled, parenchyma zone, the cells of which are elongated parallel to the surface. The vascular strands of the leaf extend into the gall through the stalk radiating around the gall cavity. The surface layer of the gall gives rise to a characteristic densely matted long-branched trichomes. The base of each trichome arises from a pyramid of compact cells (Fig. 5-C). The hair cells are elongate, uniseriate and cylindrical with granular contents. Apart from this type of trichomes, a second type, which

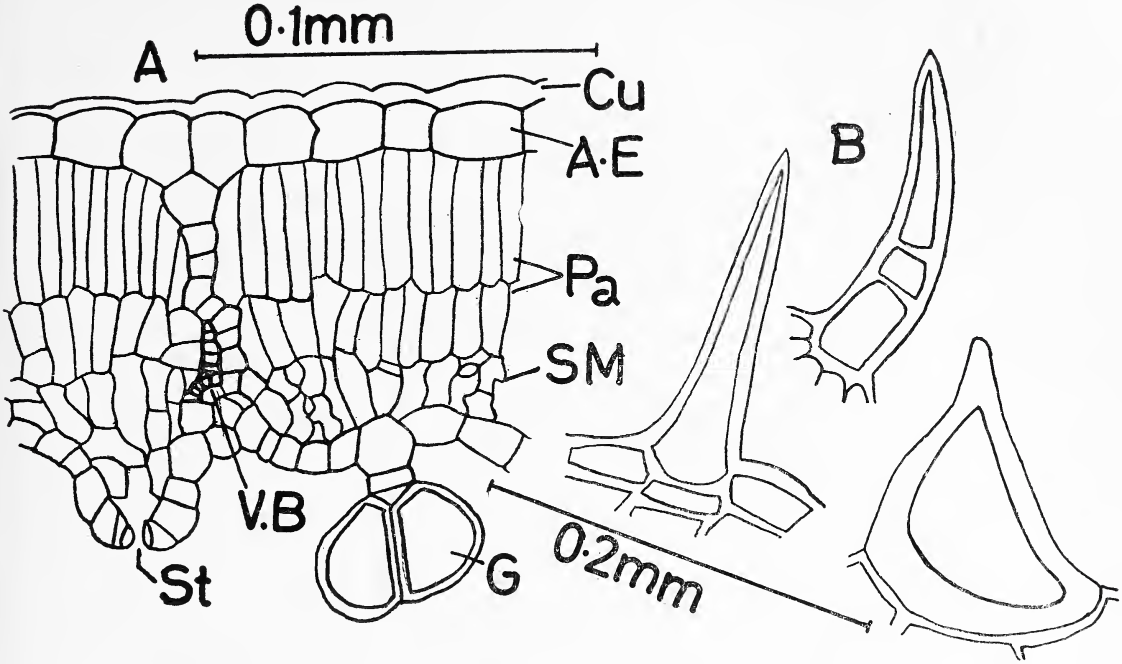

Fig. 3. *Tectona grandis* Linn.
Structural of the normal leaf and epidermal hairs.
A. T.S. of normal leaf; B. Three types of epidermal hairs on the leaf.
(A.E—Adaxial epidermis; Cu—Cuticle; G—Gland; Pa—Palisade tissue; SM—Spongy Mesophyll; St—Stoma; V.B—Vascular bundle.)

is shorter, thicker and thick-walled, also occurs mixed with the first type (Fig. 5-D).

Gall No. 899 by Gall-midge

This gall is wholly hypophyllous, but with a conspicuous epiphyllous chlorotic depression. The gall is 3 mm in diameter and 1 mm thick; pale yellow, subsessile and cup-shaped with the ostiole at the centre of depression (Fig. 6-C). The surface lacks the long brownish hairs, but is clothed with short thick-walled acute trichomes.

The course of development of this gall is more or less similar to that of gall No. 414. The gall arises as a hemispherical covering-growth with median larval cavity (Fig. 6-A). A cup-shaped meristematic zone develops around the larval cavity, which foreshadows the shape of the mature gall. The meristematic cells divide in vertical plane and grow radially, resulting in the formation of a discoid growth with a central ostiole (Fig. 6-B). Soon, the cells abutting the meristematic zone differentiate into a thin layer of sclerotic cells. The sclerotic zone extends down as a central pillar-like axis inside the stalk. The essential difference between gall Nos. 414 and 899 is in the trichomes. In the gall No. 899, the surface is densely clothed with short, stumpy, unicellular and multicellular branched hairs with extremely thick lignified walls with canal-like pits (Fig. 6-D). As these trichomes are short and dense, the surface of the gall appears smooth to the unaided eye.

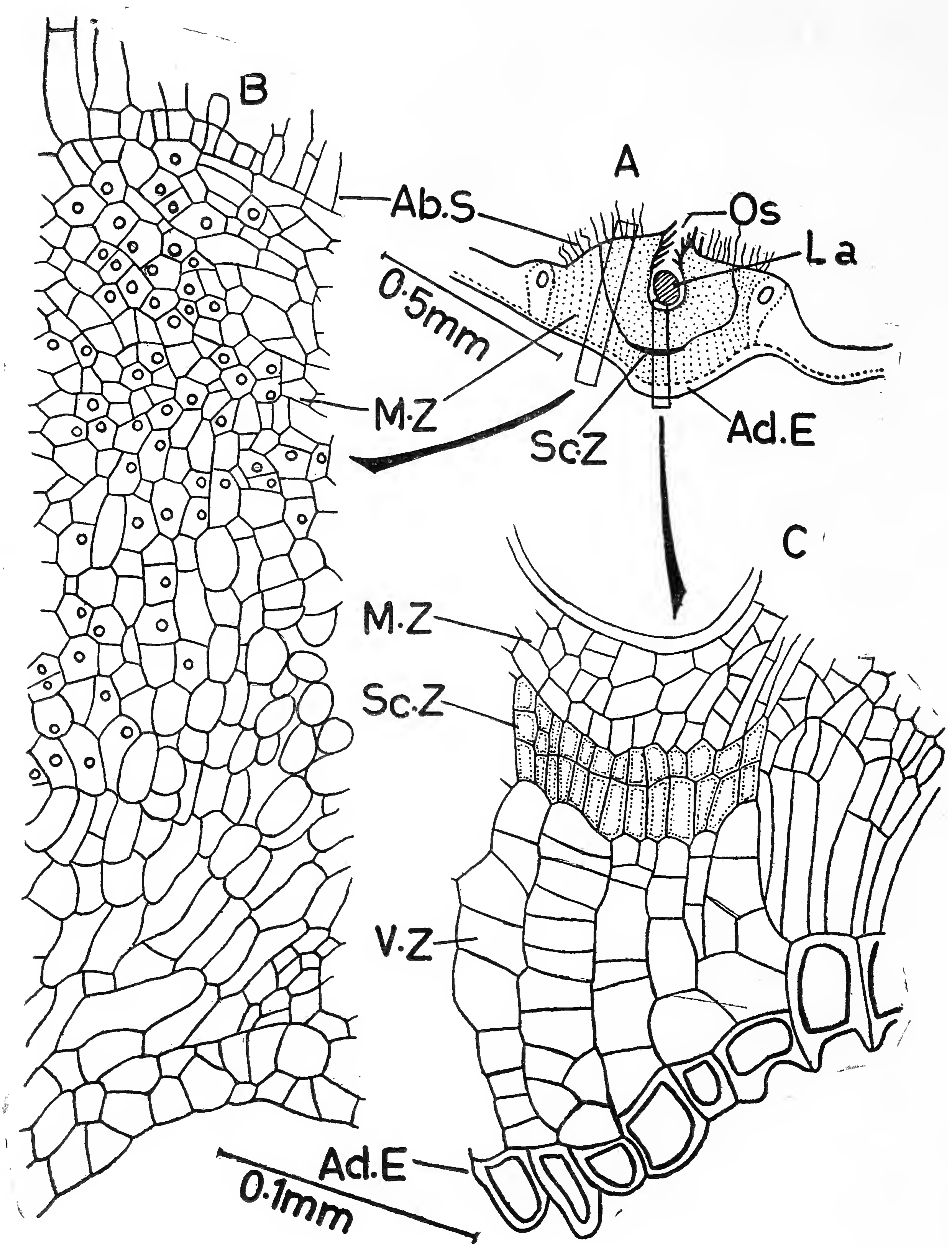

Fig. 4. *Tectona grandis* Linn. Foliar gall No. 414
A. An early stage of the gall; B, C. Two sectors of the Fig. A shown as insets. (Ab. S— Abaxial surface with epidermal trichomes; Ad. E—Adaxial Epidermis; La—Larva; M. Z—Meristematic Zone; Os—Ostiole; Sc. Z—Sclerotic zone just differentiating; V. Z—Vertically elongated cell zone.)

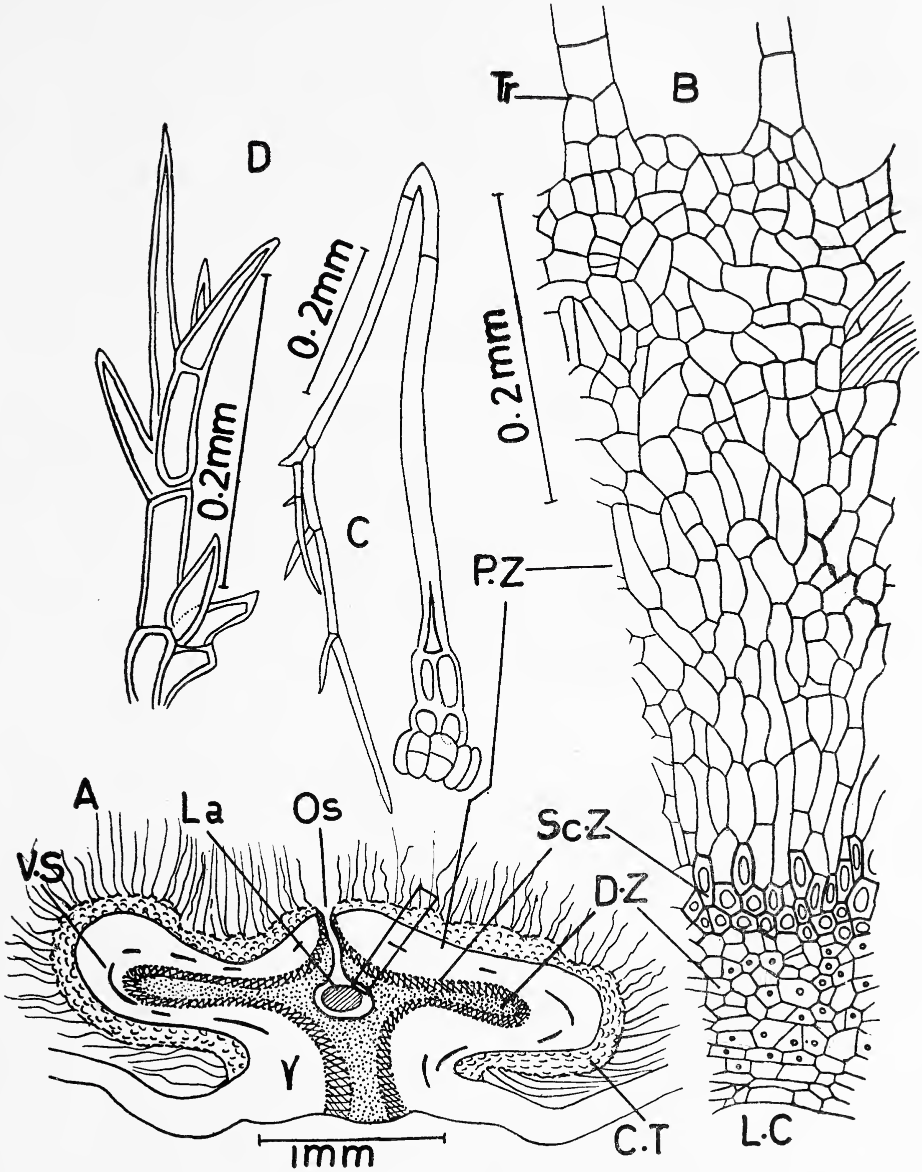

Fig. 5. *Tectona grandis* Linn. Gall No. 414
A. Vertical section of a mature gall; B. A sector of the Fig. A shown as inset; C, D. Two types of trichomes occurring on the gall surface.
(C.T—Cushion of cells from which the trichomes arise; D.Z—Dark cell zone; La—Larva; L.C—Larval chamber; Os—Ostiole; P.Z—Parenchyma zone; V.S—Vascular Strand; Tr—Trichomes.)

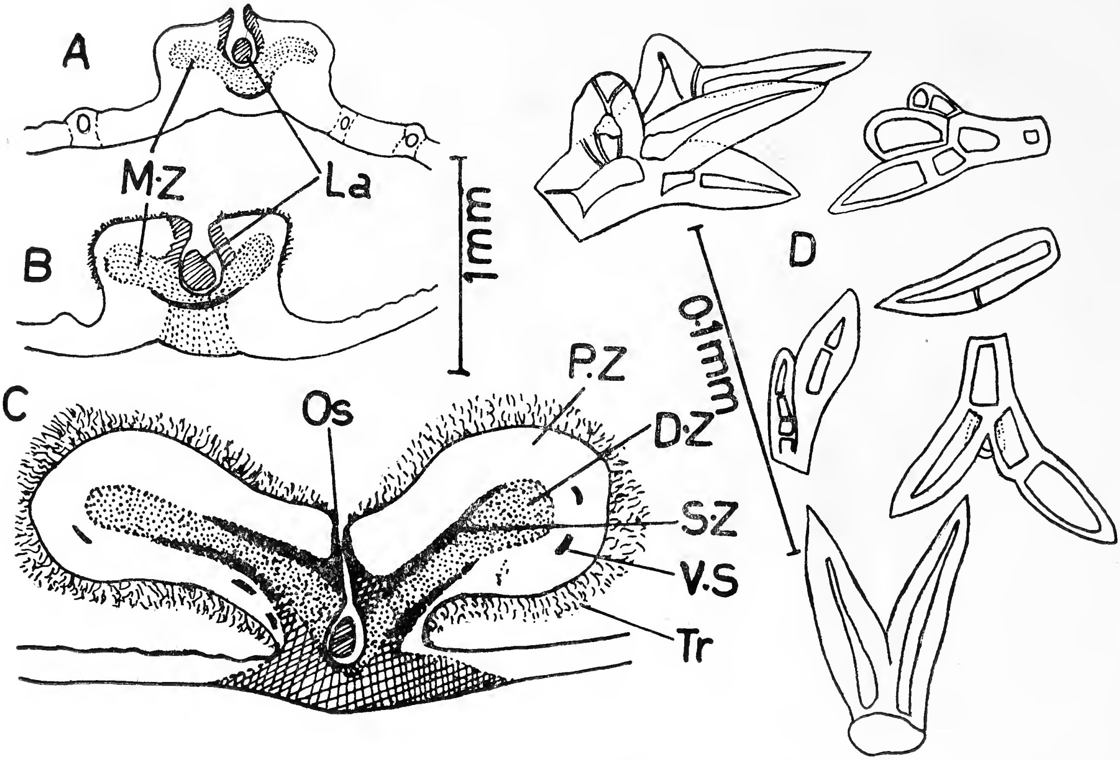

Fig. 6. *Tectona grandis* Linn. Gall No. 899
A, B. Two developmental stages of the gall; C. Vertical section of a mature gall; D. A few representative types of trichome of the gall.
(D.Z—Dark cell zone; La—Larva; M.Z—Meristematic zone; Os—Ostiole; P.Z—Parenchyma zone; S.Z—Sclerenchyma zone; Tr—Trichomes; V.S—Vascular Strand.)

Gall No. 900

Though this gall shares certain features with other two, there are basic differences. This is a lenticular gall, mostly hypophyllous, only sometimes epiphyllous, white or pale yellow, discoid and subsessile covering growth, with a short, stumpy subconical projection in the middle of the disc, where opens the ostiole (Fig. 7-A). On the lower surface of the gall, around the stalk, occur long, branched, filamentous hairs similar to those of the gall No. 414. The upper surface bears two different types of trichomes — glandular trichomes with large spherical unicellular knob and multicellular uniseriate stalk and short multicellular branched hair clusters (Fig. 7-B, C). This trichome differs from those of the gall No. 899 in the thin cell walls and larger size of cells. The larval cavity is a large circular strongly depressed, biconvex space, occupying almost to the middle of the disc (Fig. 7-A). The larval cavity is surrounded by a zone of deeply staining cells, which in turn is ensheathed by the sclerotic zone which extends below as a broad column axially into the stalk, where the sclereids are vertically elongated. The outermost zone of the gall consists of parenchyma cells arranged in layers parallel to the gall surface. This zone is vascularised as in other galls.

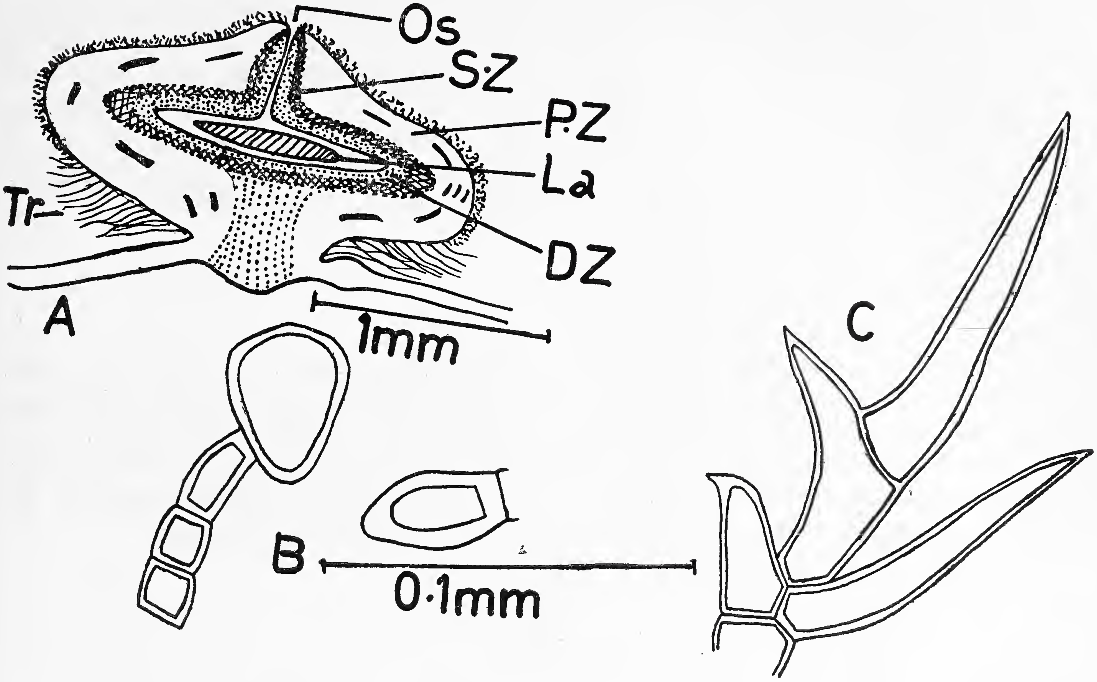

Fig. 7. *Tectona grandis* Linn. Gall No. 900
A. Vertical section of a mature gall; B, C. Trichome types of the gall.
(DZ—Dark cell zone; La— Larva; Os—Ostiole; P.Z—Parenchyma zone; S.Z—Sclerenchyma zone; Tr—Trichomes.)

Discussion

The three types of foliar galls on *Tectona grandis* display similar basic organisation inspite of certain definite structural differences. In the gall Nos. 414 and 900, there is a small central conical projection bearing the ostiole at its summit (Figs. 5-A; 7-A). In the gall No. 899, a shallow circular umbilicus-like pit is seen with the ostiole at the centre (Fig. 6-A). All the three gall types have darkly staining, small celled nutritive zone around the larval cavity followed by the sclerotic and parenchyma zones. The gall surface develops specific type of trichomes in each case, all of which differ from the trichomes of the normal leaf. The ground tissues on which these three different types of gall are built up are the same. However, they respond differently to the three different species of gall-midges, indicating that the same tissues react in different morphogenetic ways and the stimulatory agents of the cecidozoa are specific to invoke the expression of a particular potential.

It is generally believed that the epidermal tissue is relatively passive with regard to its meristematic potential (Linsbauer 1930). It is interesting to observe that in the foliar galls of *Tectona grandis*, the epidermis and its appendages are equally sensitive and reactive to the insect stimuli.

The stem gall on *Tectona grandis* induced by *Asphondylia tectonae* Mani is remarkable in its anatomical aspects. Several radially dis-

posed larval chambers occur at different levels of the gall. The cecidogenetic stimulus greatly influences the vascular cambium as a result of which the meristem is torn into several strands which ultimately differentiate into long reticulately pitted elements (Fig. 2-E). These vascular strands surround the larval chambers and serve as *'fascieux de irrigation'* reported in several galls (Mani 1964). The cortical parenchyma is greatly proliferated and some of them differentiate into brachysclereids; but they do not form definite sclerotic zone. The parenchyma cells around the larval chamber are alligned in regular concentric whorls consequent to repeated anticlinal divisions. In this respect, this tissue differs from the wound callus formed in the lepidopterous galls in which the cells are arranged in radial files due to repeated periclinal divisions. The elements of the gall tissues differ fundamentally from those of the normal stem. The stem tissues are influenced both quantitatively and qualitatively by the cecidogenetic factors and deviate from their normal course of morphogenesis.

Acknowledgement

I am greatly indebted to Dr. M. S. Mani, Professor Emeritus at the School of Entomology, St. John's College, Agra, for his sustained interest during the course of this investigation and for offering valuable suggestions during the preparation of the paper.

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TWO UNUSUAL CASES OF HOMONYMY IN ORTHOPTERA WITH NEW NAMES FOR SPECIES FROM INDIA[1]

M. S. SHISHODIA[2] AND R. K. VARSHNEY[3]

Homonymy has been reported in two cases: *Coptotettix parvulus* Hancock 1912 is preoccupied by *C. parvulus* Hancock 1909; the former is renamed here as *C. hancockus* nom. nov. *Pteronemobius panteli* Chopard 1969 is preoccupied by *P. panteli* (Hebard 1913), and *P. pantelianus* Chopard 1967 is a nomen nudum. As both the names given for the same species are invalid, it is renamed as *P. pantelchopardorum* nom. nov.

INTRODUCTION

Two unusual cases of homonymy have been determined, wherein in the first case an author (Hancock) committed homonymy himself; and in the second case, another author (Chopard) twice tried to name a new species discovered by him, but both the times failed. The first case belongs to the Tetrigid grasshoppers and the second to the crickets (Gryllids), and the species bearing junior homonyms in both cases happen to be from India.

The particulars of both species, under their valid new names, are reported in this paper.

Coptotettix hancockus nomen novum (Orthoptera: Tetrigidae)

= *Coptotettix parvulus* Hancock 1912: 145. (preoccupied)

Hancock (1909) described a new species and named it as *Coptotettix parvulus.* The material came from "Zambesi, 3000 ft., Victoria Falls, Africa — 'Rain forest' " and was collected and presented by Prof. H. Beare to the University Museum, Oxford. This is a valid species and has been catalogued by Steinmann (1962) recording its distribution in Zanzibar.

Curiously, three years later Hancock described another new species from India in 1912 and named it also as *Coptotettix parvulus.* These specimens came from "Chapra, Bengal", collected by Mackenzie. Later this species was referred by Hancock (1913) recording it further from "Dibrugarh, N.E. Assam; Kobo, 400 ft., Assam; and Janakmukh [Arunachal Pradesh]", and by Hancock (1915) recording it from "Singla, Darjeeling Distt., 1500 ft.; Kushtea [Bangladesh]; Sikkim and Calcutta" also. It was catalogued by Fletcher (1921), but strangely not included by Steinmann (1970) in his CHECK-LIST OF ORIENTAL TETRIGIDAE. Tinkham in 1937 gave to its Type specimen a label *"Paratettix parvulus"*, but does not seem to have published it.

Thus, Hancock himself committed primary homonymy and under the present situation *C. parvulus* Hancock 1912, applied to the Indian species is an invalid name. There being no other synonym of this species, it is renamed as *C. hancockus* Shishodia & Varshney, nom. nov.

[1] Accepted April 1983.

[2] Zoological Survey of India, M Block, New Alipur, Calcutta-700 053.

[3] Gangetic Plains Regional Station, B/11 Lohia Nagar, Patna-800-020, Bihar.

Diagnosis. Body small; colour brown or lighter brown, variegated with fuscous on the pronotum; head not exserted; vertex a little narrower than the width of an eye and fossulated on each side; frontal costa arcuately produced between the antennae, widely and evenly divergent forwards; antennae inserted near the lower margin of the eyes.

Pronotum short, reaching up to the middle of hind femora, widely rounded at apex; dorsum of pronotum granulate, transversely tectiform between the shoulders; median carina compressed, little arcuate forward, straight on the disc, sloping toward the apex; angles of lateral lobes of pronotum obtuse; elytra minute; hindwings not visible; the first and second pulvilli of the posterior tarsi acute spinose, the third longer.

Measurements (in mm). Male: Length of body from head to the apices of hind femora: 6.8; pronotum: 4.3; posterior femora: 4.5.

Material examined. Holotype, which is in Hancock's collection at the Academy of Natural Sciences of Philadelphia (U.S.A.) has been examined by the senior author.

Pteronemobius pantelchopardorum
nomen novum
(Orthoptera: Gryllidae)

= *Pteronemobius pantelianus* Chopard 1967: 168. (nomen nudum)

= *Pteronemobius panteli* Chopard 1969: 167. (preoccupied)

Chopard described a new species of cricket collected from "West Bengal: Kurseong". Naming it as *Pteronemobius panteli* he included its description for publication in his volume on the Grylloidea in the FAUNA OF INDIA series. It may be assumed that he must have submitted it for publication before "26.10.1964", the date on which he has signed the preface to this volume. However, the FAUNA volume itself was published and released after about five years only in April 1969.

It further appears that soon after submitting the manuscript of the FAUNA volume, he perhaps found out that the name *Pteronemobius panteli* is preoccupied by *Pteronemobius panteli* (Hebard 1913). Hence, Chopard renamed his species as *Pteronemobius pantelianus* and included it as such in his WORLD CATALOGUE OF GRYLLIDS, which was published in July 1967. Unfortunately, he neither corrected his MSS of the FAUNA volume, nor mentioned about his *P. panteli* in the CATALOGUE. Perhaps he was sure that the FAUNA volume would be published and released within 1967, and under this assumption he gave full citation and pagination of all taxa dealt within the FAUNA volume, in the CATALOGUE; and mentioned 1967 as the year of publication of the FAUNA, which was incidentally not correct.

Under the circumstances, a nomenclatural confusion exists regarding this species. Looking through the original publications and with the application of Articles under the INTERNATIONAL CODE OF ZOOLOGICAL NOMENCLATURE, it is hereby concluded that (i) *P. pantelianus* Chopard 1967 is a nomen nudum, since no indication, description or illustration accompanied this proposal, except mentioning of the collection locality of the specimens and an incorrect reference to his then unpublished FAUNA volume. In fact, Chopard (1967) has not used either 'sp. n.' or 'nom. nov.' epithets or any other words to these effects while publishing the name *pantelianus*; (ii) *P. panteli* Chopard 1969 is a preoccupied name by *Nemobius panteli* Hebard 1913, a species occurring in Mexico and Costa Rica, which has been subsequently brought under the genus *Pteronemobius*, and shown in this combination by Chopard (1967). (Incidentally the entry of *"panteli"* is missing in the Index of the FAUNA volume.) Thus, Chopard twice tried to name his species but failed both the times. *P. panteli* Chopard 1969, presently stands as a

junior secondary homonym and must be rejected; (iii) there being no other valid name available for this species, it is renamed as *P. pantelchopardorum* Shishodia & Varshney, nom. nov.

Diagnosis. Body rather short and stout; colour uniformly brown, or dark brown, shining, almost glabrous except for the long bristles; head big, rounded; vertex sloping; eyes rounded; ocelli yellow; antennae brown; maxillary palpi brown with the last two joints white, 3rd and eighth tergite of abdomen with white band dorsally.

Male: Posterior tibiae armed with 3 external and 4 internal spines, the first spine tuberculiform and the 4th strongly swollen at base; elytra extending to the apex of abdomen; mirror divided into two almost equal parts by an oblique vein; diagonal vein long, feebly curved at base; hindwings absent.

Female: Posterior tibiae armed with 3 spines on each margin; elytra a little shorter than the abdomen; dorsal field with 4 parallel, almost equidistant veins, the 2nd furcate near the apex, the 3rd and 4th united a little before the apex; ovipositor short, feebly curved; hind wings absent.

Measurements (in mm, *vide* Chopard 1969). Length of body: 5; pronotum: 1.2; posterior femora: 4; elytra (male): 3.4; elytra (female): 2.2; ovipositor: 2.5.

Material examined. Holotype is stated to be in Pantel's collection, at the Museum National d'Histoire Naturelle, Paris (France). We have examined identified specimens of it in the Zoological Survey of India, Calcutta.

Acknowledgements

We are very grateful to Dr. R. V. Melville, Secretary, International Commission on Zoological Nomenclature, London, for confirming the observations regarding *P. panteli* and *P. pantelianus.* We also record thanks to the Director, Zoological Survey of India, Calcutta, for facilities.

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NEW DESCRIPTIONS

A NEW SPECIES OF *ASYNAPTA* LOEW (DIPTERA: CECIDOMYIIDAE: PORRICONDYLINAE) FROM AURANGABAD, INDIA[1]

R. M. SHARMA[2]

(*With twelve text-figures*)

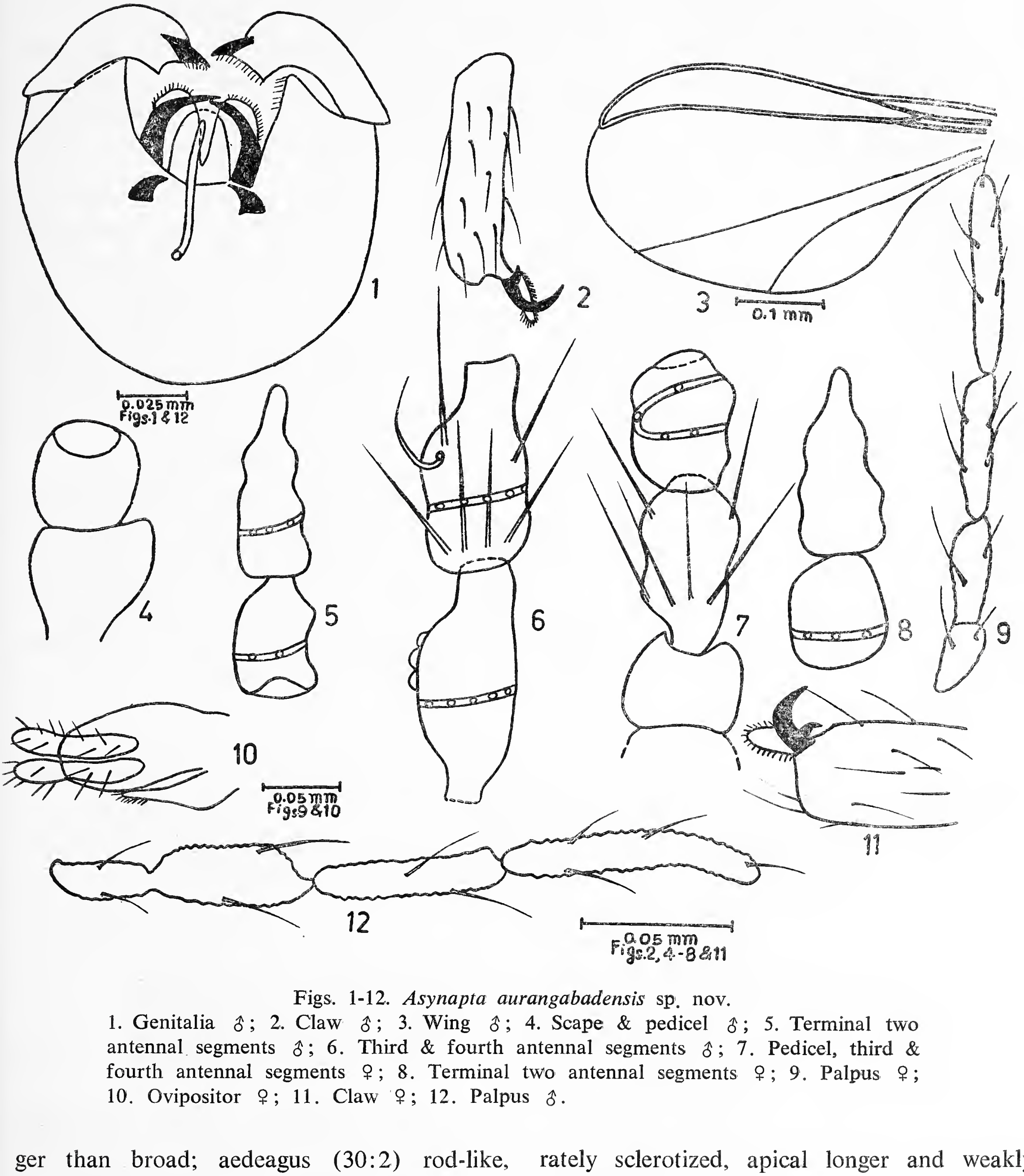
Asynapta aurangabadensis sp. nov.

(Figs. 1-12)

MALE: Body 1.28 mm long. Eyes confluent above. *Palpus*: quadriarticulate, long, light-straw, sparsely setose, densely hairy with wrinkled surface; first segment (17:7) cylindrical, length 2.42 × its maximum thickness; second segment (25:9) cylindrical, 1.47 × longer than first, length 2.77 × its maximum thickness; third segment (33: 7), 1.32 × longer than second, length 4.71 × its maximum thickness; fourth segment (44:6) cylindrical, longest of all, length 7.33 × its maximum thickness. *Antenna*: Shorter than body with 2 + 14 cylindrical segments, enlargements with low circumfila and two whorls of long setae, stems short; scape (15:15) cup-shaped; pedicel (15: 12) sub-globose; third segment (32) longer than and not confluent with fourth, basal stem (3:7); enlargement (22:13) a little less than 0.70 the length of the segment and nearly 1.70 × its maximum thickness; stem (7:7) 0.31 the length of the enlargement and as long as thick; fourth segment (29) with enlargement (20:13) 0.69 the length of the segment and a little less than 1.54 × its maximum thickness, stem (9:7) 0.45 the length of the enlargement and 1.28 × its maximum thickness; fifth segment (29) similar to the fourth; distal segments becoming shorter; penultimate segment (15) shortest of all, enlargement (13:10) 0.86 the length of the segment and 1.30 × its maximum thickness, stem (2:2) very short, 0.15 the length of the enlargement and as long as thick; terminal segment (25), enlargement (19:10) 0.76 the length of the segment and 1.90 × its maximum thickness, stem (6:4) in the form of an apical nipple-like prolongation, 0.32 the length of the enlargement and 1.50 × its maximum thickness. *Wing*: (58:29) hyaline, 2.00 × as long as broad, vein *R*5 curved, reaching wing margin a little beyond apex, vein *M*1+2 complete, vein *Cu* simple. *Legs*: Long, moderately hairy, metatarsus (5) shorter than terminal tarsal segment (10); second tarsal segment (35) longest of all, shorter than the following segments combined together (40); claw evenly curved, dentate on all legs; empodium as long as claw (7:7). Abdomen narrow and recurved terminally. *Genitalia*: Yellowish-brown, sparsely setose, basal clasp segment (56:28) cylindrical, length 2.00 × its maximum thickness; terminal clasp segment (30:11) slender, broadest subapically, ending in a strong tooth, lower margin fringed with short setae, a little less than half the length of the basal clasp segment and 2.72 × its maximum thickness; dorsal plate (20:20) deeply bifid, densely hairy, lobes rounded apically, longer than subdorsal plate; later (31:11) entire, broadly rounded apically, slightly lon-

[1] Accepted April 1985.

[2] Zoological Survey of India, Western Regional Station. Pune - 411 016.



Figs. 1-12. *Asynapta aurangabadensis* sp. nov.
1. Genitalia ♂; 2. Claw ♂; 3. Wing ♂; 4. Scape & pedicel ♂; 5. Terminal two antennal segments ♂; 6. Third & fourth antennal segments ♂; 7. Pedicel, third & fourth antennal segments ♀; 8. Terminal two antennal segments ♀; 9. Palpus ♀; 10. Ovipositor ♀; 11. Claw ♀; 12. Palpus ♂.

ger than broad; aedeagus (30:2) rod-like, reaching upto subdorsal plate, length 15.00 × its maximum thickness; two pairs of claspette in the form of curved spines, encircling dorsal & subdorsal plates; basal one short, moderately sclerotized, apical longer and weakly sclerotized.

FEMALE: Body 2.55 mm long including ovipositor. *Palpus* as in male. *Antenna* shorter than body, with 2 + 14 sessile, cylindrical seg-

ments, constricted in the middle, with low circumfila and two whorls of long setae; scape not clear in preparation, pedicel (14:15) subglobose; third segment (23) not confluent with and longer than fourth, with a small basal prolongation (3:6), enlargement (20:12) 1.66 × its maximum thickness; fourth segment (17:12) 1.41 × its maximum thickness; fifth segment (16:11) shorter and thinner than fourth, length 1.45 x its maximum thickness; distal segments gradually decreasing in size; penultimate segment (12:11); terminal segment (25:10) longest of all, with apical nipple-like prolongation, length 2.50 × its maximum thickness. Wing, legs, claw and abdomen as in male. *Ovipositor*: lamellate, basal lamellae (28:8) oblong, 3.50 × as long as broad, terminal lamellae (14:6) oval, setose, half the length of basal and 2.33 × as long as broad, ventral lamella short.

Holotype: ♂ at light, Khadkeshwar, Aurangabad, Maharashtra, India, R. M. Sharma coll. Dated 6.vii.1976. Dissected and mounted on slide.

Allotype: ♀ and *Paratypes*, 2 ♀♀ dissected and mounted on slides, data as in Holotype. All types are deposited in the collections of Zoological Survey of India, Pune for the time being.

Remarks: This species closely resembles *A. indica* (Grover) but can be readily distinguished from it in the following set of characters: i) different number and proportions of the antennal segments; ii) basal clasp segment without apical lobe; iii) subdorsal plate being entire; iv) simple claspette and v) straight aedeagus.

ACKNOWLEDGEMENTS

I am thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and the Officer-in-Charge, Zoological Survey of India, Pune, for facilities, I am greatly indebted to Prof. S. N. Rao (Retd.), Dept. of Zoology, Marathwada University, Aurangabad for encouragement and guidance.

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ON A NEW CYPRINID FISH OF THE GENUS *DANIO* HAMILTON (PISCES: CYPRINIDAE) FROM MANIPUR, INDIA[1]

R. P. BARMAN[2]

(With a text-figure)

A new cyprinid fish of the genus *Danio* Hamilton collected from Manipur, India is being described and illustrated under the name *Danio manipurensis* in this paper. It is closely related to *Danio naganensis* Chaudhuri (1912) from Naga Hills, Nagaland from which it differs in lateral line scale, predorsal scales and dorsal fin rays counts and body depth and eye diameter.

INTRODUCTION

The cyprinid fishes of the genus *Danio* Hamilton are distributed throughout the Indian subcontinent, Thailand, Malay Peninsula, Sumatra and China. Day (1889) recorded 10 species and Jayaram (1981) enumerated 17 species belonging to the genus *Danio* from the Indian subcontinent. Barman (1983, 1984a, 1984b, 1985) discovered four new species

[1] Accepted January 1986.

[2] Zoological Survey of India, Calcutta.

under the genus from India and Burma. While studying the taxonomy of the cyprinid genus *Danio* from the Indian subcontinent, 18 specimens of a species referable to the genus were found and examined. When compared with the known species under the genus, they proved to be of a hitherto undescribed species. The new species is being described under the specific name *Danio manipurensis* in this paper after its locality.

Danio manipurensis sp. nov.

Material: *Holotype* (Fig. 1): 25 mm. SL. Reg. No. Zoological Survey of India, Calcutta FF1999. Locality: Manipur, India. Coll. Dr. S. L. Hora. Date of collection: 8.3.1920. *Paratypes*: 17 examples, 16 mm. - 38 mm. SL. Reg. No. Zoological Survey of India, Calcutta FF2000. Locality, collector and date of collection same as in holotype.

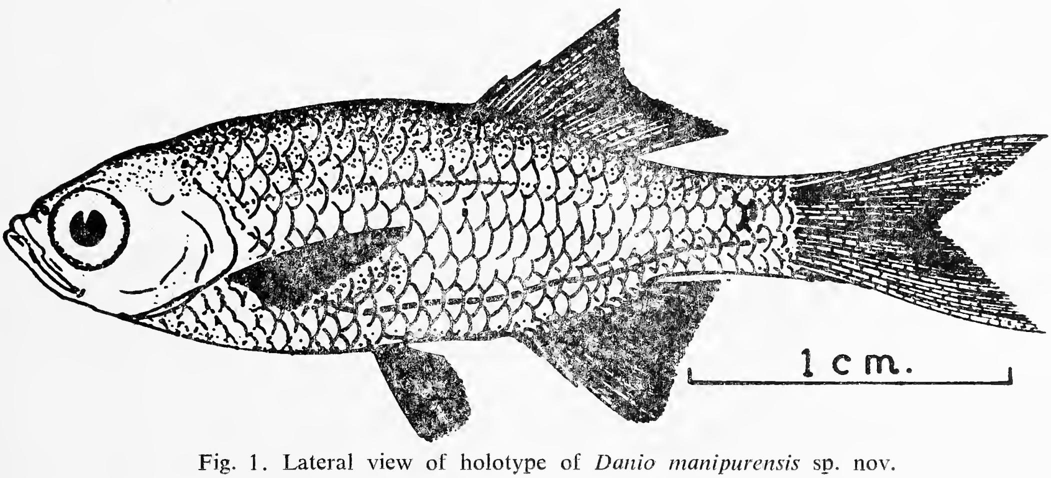

Fig. 1. Lateral view of holotype of *Danio manipurensis* sp. nov.

Diagnosis

Head length 3.33-3.87 and body depth 3.00-3.30 in standard length. Eye diameter 2.66-3.00 in head length. Least depth of caudal peduncle 1.20-1.25 in its length. Barbels 2 pairs, maxillary pair shorter than rostral pair. Lateral line scales 33-34.

Description

Head length 3.33-3.87 and body depth 3.00-3.30 in standard length. Eye diameter 2.66-3.00 in head length, 1.10-1.33 in interorbital width. Snout length 3.75-5.00 in head length, 1.50-2.00 in interorbital width. Snout shorter than eye diameter. Mouth obliquely directed upward, lower jaw longer than upper jaw, with a symphysial knob. The maxilla extending anterior margin of the orbit. Barbels 2 pairs, the rostral pair half the length of eye diameter and maxillary pair half of the rostral pair. Minimum depth of caudal peduncle 1.20-1.25 in its length.

Scales: Lateral line complete with 33-34 scales. Lateral transverse scales 8-9; $1\frac{1}{2}$ rows of scales between lateral line and base of pelvic fin. Predorsal scales 14-15 and circumpeduncular scales 10.

Fins: D. ii-iii, 10-11; A. ii-iii, 12-13; P. i, 12-13; V. i, 6-7; C. 19. Dorsal fin originates in the opposite interspace between pelvic and anal fin, nearer to base of caudal fin than to tip of snout. Pectoral fin extending the base of pelvic fin. Both pectoral and pelvic fin possess

scaly flap or appendages at their bases. Caudal fin emarginate, almost equal to head.

Colour in alcohol: A light darkish longitudinal straight narrow band extending from behind the head to base of caudal fin. Fins are hyaline.

Detailed measurements of different body proportions of this species are given in table 1.

Distribution: *Danio manipurensis* is known only from Manipur, India (Latitude 23.8°N to 25.8°N and Longitude 93°E to 95°E).

Discussion

Danio manipurensis sp. nov. is closely related to *Danio naganensis* Chaudhuri but can be easily separated from the latter species by the much deeper body depth 3.00-3.30 vs. 3.60-4.16, longer eye diameter 2.66-3.00 vs. 3.33-4.33 in head length, least depth of caudal peduncle much deeper 1.20-1.25 vs. 1.50-2.00 in its length, fewer number of lateral line scales 33-34 vs. 40-42, dorsal fin rays more numerous 12-14 vs. 10 and predorsal scales 14-15 vs. 18-20.

Acknowledgements

I thank Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for laboratory facilities and Dr. K. C. Jayaram, Joint Director, Zoological Survey of India, Calcutta for his valuable suggestions. I also thank Dr. P. K. Talwar, Deputy Director, Zoological Survey of India, Calcutta for his encouragement.

Table 1

Measurements of different body proportions of *Danio manipurensis* sp. nov.

Proportions	Range	Mean
Standard length/Head length	3.33-3.87	3.62
Standard length/Body depth	3.00-3.30	3.14
Standard length/Predorsal distance	1.65-1.72	1.67
Standard length/Prepelvic distance	2.00-2.13	2.07
Standard length/Preanal distance	1.59-1.68	1.63
Standard length/Caudal peduncle length	5.00-6.33	5.66
Head length/Depth of head	1.11-1.33	1.22
Head length/Width of head	1.60-2.00	1.78
Head length/Eye diameter	2.66-3.00	2.82
Interorbital width/Eye diameter	1.00-1.33	1.16
Head length/Snout length	3.75-5.00	4.37
Interorbital width/Snout length	1.50-2.00	1.75
Standard length/Length of longest dorsal fin ray	4.50-5.33	4.98
Standard length/Length of longest anal fin ray	5.00-6.75	5.90
Standard length/Pectoral length	3.85-4.57	4.28
Standard length/Pelvic length	6.25-8.00	7.16
Standard length/Length of caudal fin	3.25-3.80	3.58
Length of caudal peduncle/ Depth of caudal peduncle	1.20-1.25	1.23

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OPHIOPINOTUS PINOTUS GEN. ET SP. NOV. (HYMENOPTERA: TORYMIDAE)[1]

Tasawwer Husain and Prem Prakash Kudesia[1]

(*With seven text-figures*)

Ophiopinotus has been proposed as a new genus with *Ophiopinotus pinotus* sp. nov. as the type-species in the family Torymidae.

Ophiopinotus gen. nov.

FEMALE: Body coloration mostly black; head densely pubescent, toruli placed just below the middle of frons; scape short not reaching front ocellus; occipital carina absent; mandibles tridentate; maxillary and labial palpi 4 and 3-segmented respectively; antennae 13-segmented (11173); thorax with densely pubescence; propodeum with inverted 'V' shaped carinae; hind femora narrow with one tooth at subapex; gaster short, compact, tergites I-II glabrous, III-VII densely setose, exerted part of ovipositor as long as the length of gaster.

Female length: 5.00-5.80 mm.

Type-species: *Ophiopinotus pinotus* sp. nov. (Monotypic).

Comments: *Ophiopinotus* gen. nov. differs from closely related genus *Ditropinotus* Crawford, 1907 in the general coloration of the body, antennae with one annellus, propodeum with inverted 'V' shaped carinae, hind femora narrow with one tooth at subapex, exerted part of ovipositor as long as length of gaster.

Ophiopinotus pinotus sp. nov. (Figs. 1-7)

FEMALE

Body colour mostly black except eyes, ocelli, apices of fore and mid femora, tibiae and tarsi of all legs pinkish yellow.

Head — Wider than long in facial view, unpitted with dense pubescence of silvery white hairs; scrobe cavity shallowly excavated, unlimited; toruli situated just below middle of frons; ocelli in obtuse triangle, malar space shorter than major axis of eyes; occipital carina absent; pre-orbital carinae absent, post-orbital carinae distinct (Fig. 1); mandibles tridentate (Fig. 2); maxillary and labial palpi 4 and 3- segmented respectively. Antennae (Fig. 3) 13- segmented, scape short, not reaching front ocellus, 5 times as long as wide, as long as 2.5 preceding funicle segments combined; pedicel 1.5 as long as wide; annellus 2.0 wider than long; F1-3 wider than long, F4-6 as long as wide, F7 longer than wide; club 3-segmented, less than three times as long as wide, as long as preceding 2.5 funicle segments combined.

Thorax — Unpitted, with dense pubescence except glabrous at apex of scutellum, apex of scutellum rounded. Forewings (Fig. 4) — hyaline, about 2.5 as long as wide, wing disc with few setae below submarginal, rest part of disc densely setose, submarginal 1.5 of marginal, marginal 1.7 of postmarginal, stigmal shorter than postmarginal. Hindwings — hyaline, about 3.5 as long as wide. Propodeum (Fig. 5) — with inveryed 'V' shaped carinae. Hind legs (Fig. 6) — coxae about twice as long as wide, transversely striated, outermargin with long setae; femora strong, narrow, with one pointed tooth at subapex, densely setae, tibiae with one spur at apex.

Gaster (Fig. 7) — Acuminate at apex, shorter than thorax, tergites short, I-II glabrous, III-IV densely setose, exerted part of ovipositor as long as length of gaster.

Female length: 5.00 mm.

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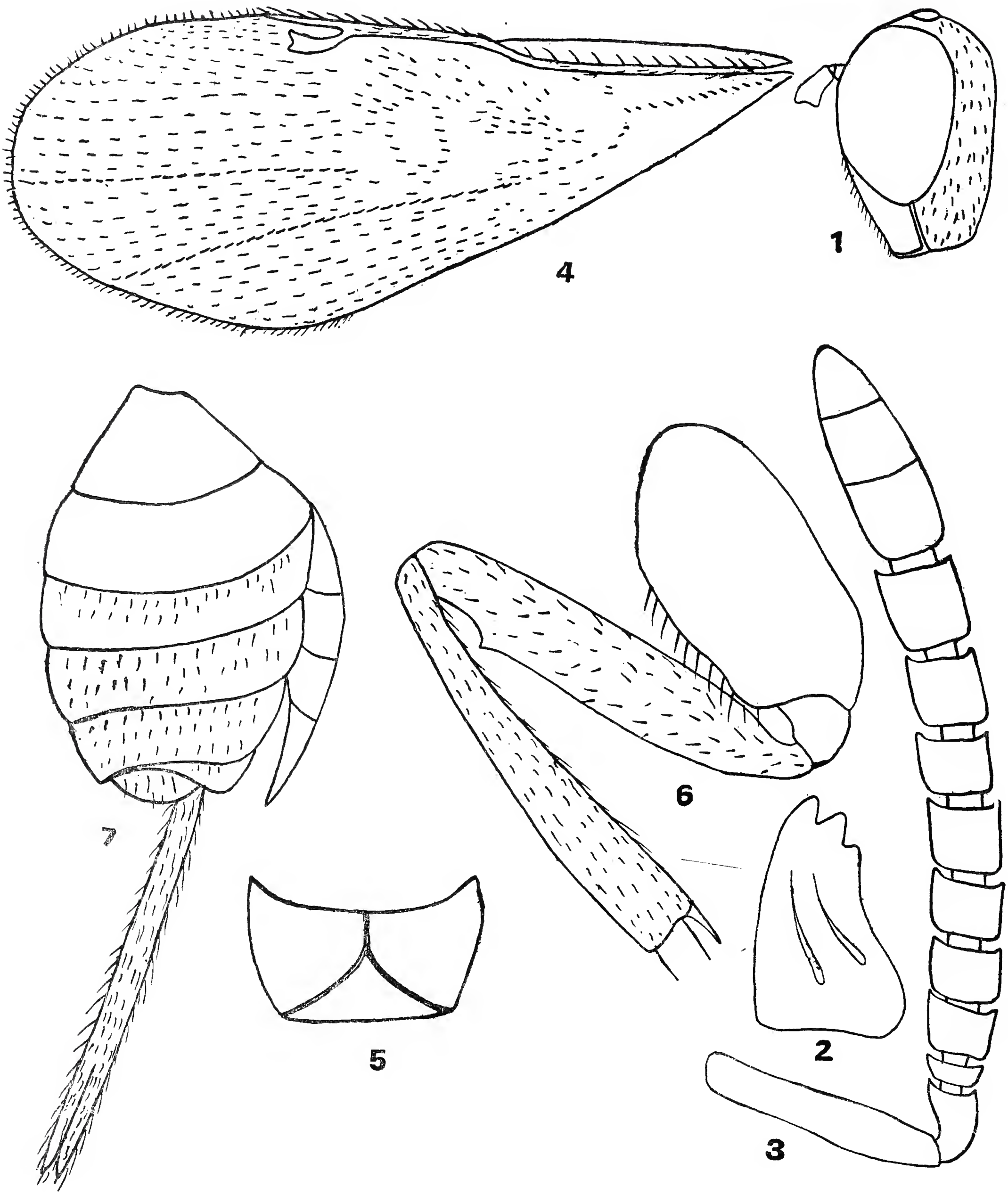

Figs. 1-7. *Ophiopinotus pinotus* sp. nov. ♀: 1. Head (lateral view); 2. Mandible; 3. Antenna; 4. Fore wing; 5. Propodeum; 6. Hind leg; 7. Gaster.

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TAXONOMIC STUDIES ON THE MARINE OSTRACODA FROM THE EAST COAST OF INDIA[1]

C. Annapurna and D. V. Rama Sarma[2]

(*With four plates*)

Introduction

While investigating the systematics and ecology of benthic ostracods, 40 species belonging to 27 genera and 14 families were identified from the marginal marine/estuarine environments, namely Bimili backwaters (17°54′N; 83°28′E), Balacheruvu tidal stream (17°39′N; 83°15′E), and Vasishta Godavari estuary (16°18′N; 81°42′E).

Among the members of the family Cytheridae Baird 1850, *Cythere dentaculatum, Neomonoceratina indica, N. spinosa* and *Eopaijenborchella subcaudatum* are new to science; *Cythere darwinii* and *Hemicytheridea truncatula* were recorded for the first time from Indian waters. *Palmenella mckenzii* Annapurna and Rama Sarma 1985 was described earlier from the Bimili backwater, on the east coast of India (Annapurna & Rama Sarma 1985).

Cythere darwinii Brady, 1868
(Pl. 1, Fig. A)

Lateral outline elongate-ovate. Anterior end evenly rounded,posterior end narrowly rounded below and compressed above. Dorsal margin straight. Ventral margin turns upwards towards the posterior end. Surface of the carapace ornamented with a larger pit with numerous small punctae in between the smaller arranged in rows behind the anterior and posterior margins. Hinge amphidont type. In the left valve the median hinge bar crenulate, smooth in the right valve. Normal pores numerous, central muscle scars in the form of vertical row of 4 adductor scars with one frontal scar. Eye spot absent. Left valve larger than right. Right valve dorsally higher than the left.

Length 0.88 mm; height 0.49 mm.

Occurrence: Backwaters of Bimili and Balacheruvu tidal stream.

Distribution: Northwestern Europe, North America, Japan.

Cythere dentaculatum sp. nov.
(Pl. 1, Fig. B; Pl. 2, Fig. 1)

Carapace laterally compressed. Ventral margin sinuate, dorsal margin straight, maximum height approximately at the anterior end. Surface sculptured with strong ridges and fossae arranged parallel to the ridges. Anterior end rounded, bears marginal denticulations. Posterior end truncate, bears two marginal denti-

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culations. Hinge merodont/entomodont type. Inner lamella widest anteriorly. Marginal pore canals not clear. Central muscle scars in the form of 4 adductor scars and one fulcral V-shaped scar. Normal pores numerous and fairly wide. Length 0.60 mm; height 0.27 mm.

Remarks: The present form differs from known species of the genus *Cythere* Müller in surface sculptured with strong ridges and fossae arranged parallel to the ridges. Anterior end rounded and consists of marginal denticulations, posterior end truncate and consists of marginal denticulations.

Type-locality: Bimili backwater, east coast of India.

Type-specimens: Holotype and 2 paratypes are deposited in the Museum of Zoological Survey of India, Calcutta, India.

Occurrence: Backwaters of Bimili (India).

Genus: *Hemicytheridea* Kingma, 1948

Hemicytheridea truncatula (Brady, 1868)
(Pl. 1, Fig. C; Pl. 3, Figs. 1-7)

In lateral view the valves are elongate, subreniform in outline, strongly resembling those of *Cytheromorpha* and *Leptocythere.* Dorsal margin straight, ventral margin sinuous. Highest in the anterior cardinal angle, posterior end turned upwards. Anterior end broadly rounded, posterior end truncate. Surface sculptured with rounded fossae. Marginal denticulations absent. Valves moderately heavily calcified. Hinge amphidont type. In the left valve a smaller anterior socket present. Subtriangular in lateral view. In front of this socket is a slightly projecting tooth which is widest dorsally and subacute below. Behind the socket lies a long crenulate bar. The posterior tooth of right valve serrate. The median hinge-element of the right valve are complementary to those in the left valve. The inner-lamella moderately wide anteriorly, comparatively narrow vestibulum present. Marginal pore canals moderately few, simple and straight. Central muscle scars vertical row of 4 adductor scars with one frontal scar.

Length 0.57 mm; height 0.30 mm.

Antennule 5-segmented, penultimate podomere with 2 claw-like setae. Ultimate podomere short, ends with 2 claw-like setae. Antenna 5-jointed, spinneret seta well developed, ultimate podomere with 2 claw-like setae and 2 slender setae. Mandible with 5 serrate teeth placed laterally on cutting edge. Mandibular palp 4-segmented, the first segment bulbous, second segment with one slender seta, ultimate segment with 2 long feathered ventral bristles and 5 slender and elongated setae. Maxilla with 3 short, broad masticatory lobes each with short setae, vibratory plate bears unfeathered rays. Thoracic legs 4 segmented, each ends with slender setae. Distal ends of each segment with short setae.

Occurrence: Backwaters of Bimili and Vasishta Godavari estuary (India).

Distribution: Indo-Pacific region.

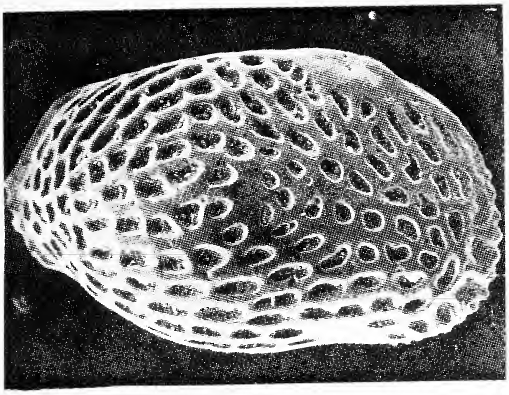
Genus: *Neomonoceratina* Kingma, 1948

Neomonoceratina indica sp. nov.

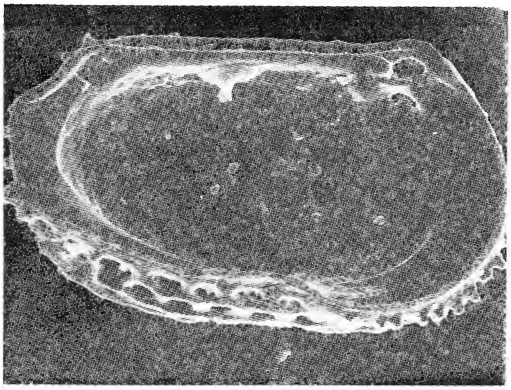
(Pl. 1, Fig. D; Pl. 2, Figs. 2, 3; Pl. 4, Figs. 1-10)

Carapace subrhomboidal in lateral view, the height generally equals more than half the length. Dorsal margin straight, ventral outline sinuous. Anterior end obliquely truncated above, rounded below. Posterior end with clear caudal process situated above the middle. Valves rather deep, pronounced vertical subcentral sulcus dividing them into 2 inflated parts. Anterior and posterior peripheral areas compressed laterally. Each valve with two closely set ventral longitudinal ridges; intercostal areas reticulate. Hinge amphidont type, anterior and posterior ends smooth, median hinge element crenulated in the left valve. Inner lamella wider at anterior end than poste-

PLATE 1



A



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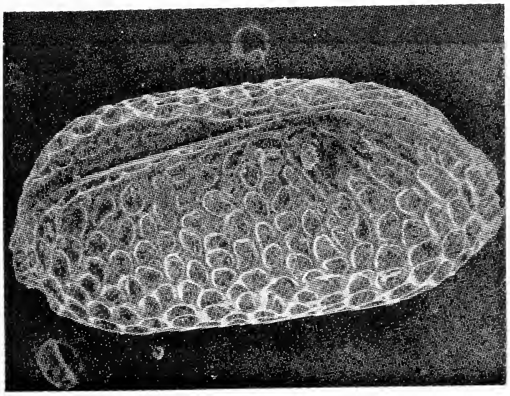

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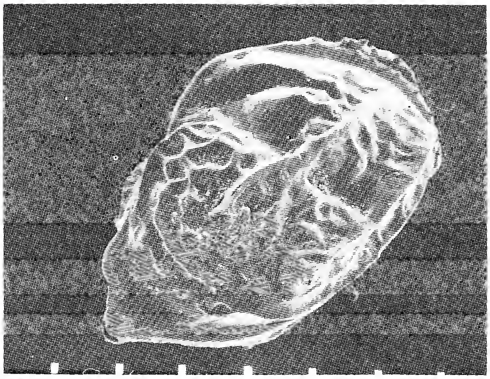
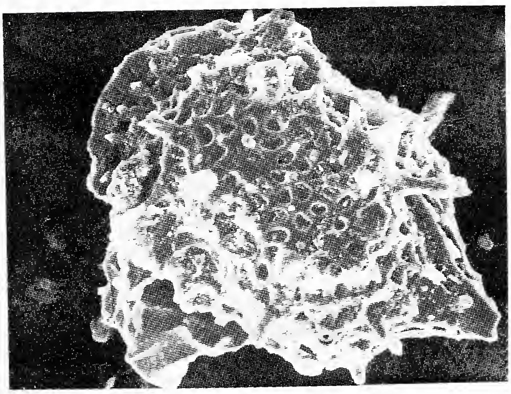
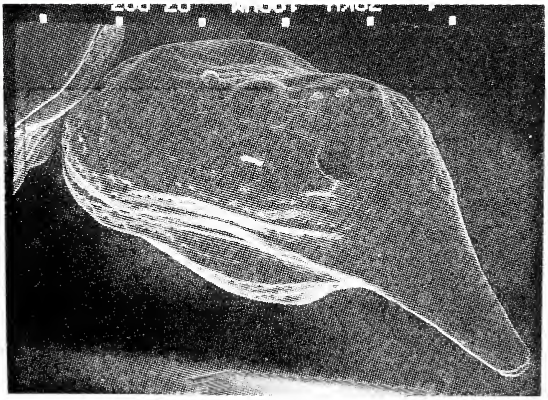


D

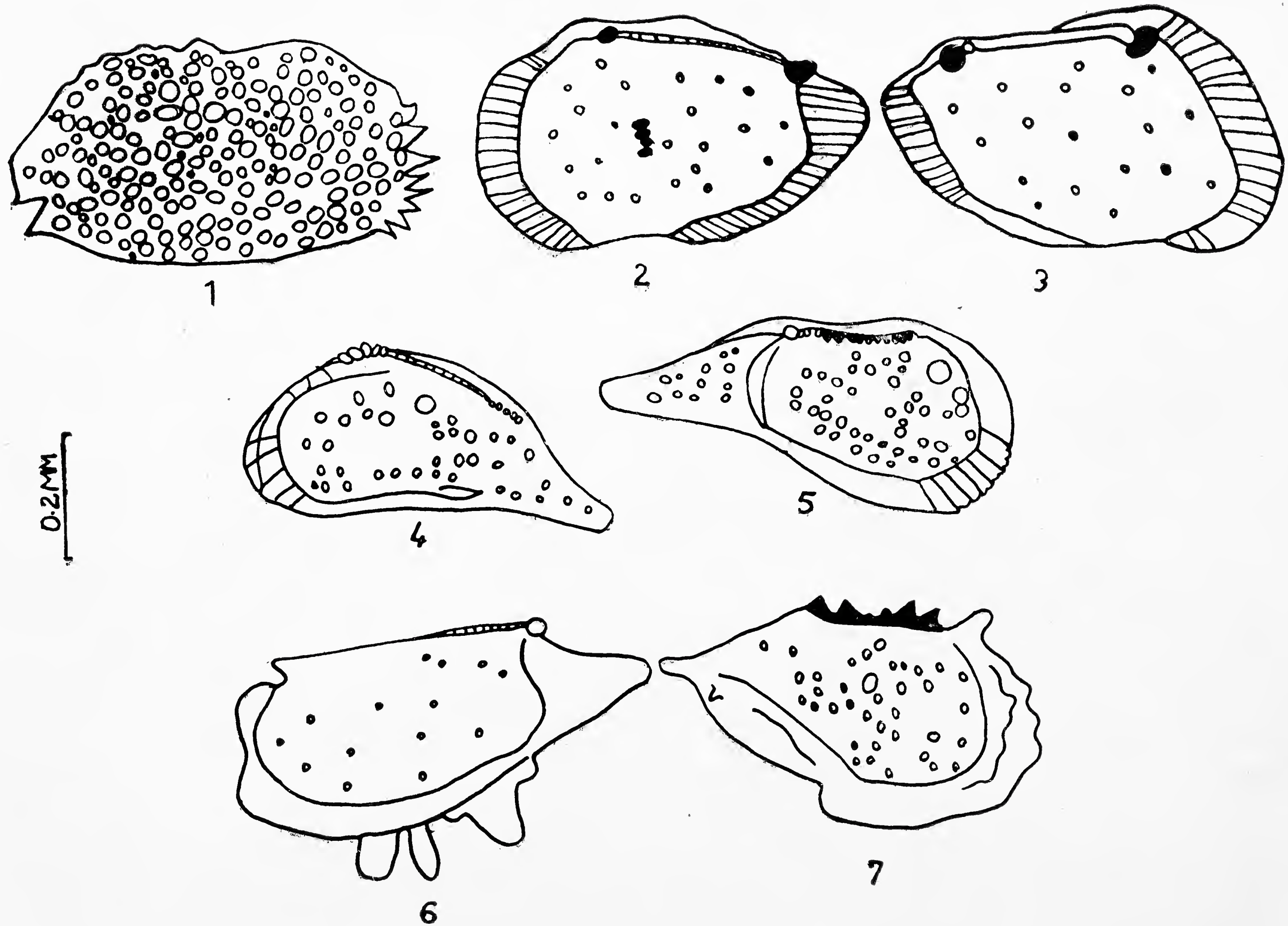


E



F

A. *Cythere darwinii* — Exterior view of right valve. B. *Cythere dentaculatum* — Interior view of left valve. C. *Hemicytheridea truncatula* — Exterior view of complete shell. D. *Neomonoceratina indica* — Exterior view of left valve. E. *Neomonoceratina spinosa* — Exterior view of left valve. F. *Eopaijenborchella subcaudatum* — Exterior view of complete shell.



1. *Cythere dentaculatum* — Exterior view. 2. *Neomonoceratina indica* — Interior view of left valve. 3. *Neomonoceratina indica* — Interior view of right valve. 4. *Neomonoceratina spinosa* — nterior view of left valve. 5. *Neomonoceratina spinosa* — Interior view of right valve. 6. *Eopaijenborchella subcaudatum* — Interior view of right valve. 7. *Eopaijenborchella subcaudatum* — Interior view of left valve.

Hemicytheridea truncatula

1. Antennule; 2. Antenna; 3. Mandible with palp; 4. Maxilla; 5. First thoracic leg; 6. Second thoracic leg; 7. Third thoracic leg.

Neomonoceratina indica sp. nov.

1. Antennule; 2. Antenna; 3. Mandible; 4. Mandibular palp; 5. Maxilla; 6. Mid masticatory lobe of maxilla; 7. First thoracic leg; 8. Second thoracic leg; 9. Third thoracic leg; 10. Genital organ.

rior end. Marginal pore canals simple and straight. Normal pores moderately few, central muscle scars not known in detail. Eye spot absent. Left valve slightly larger than the right.

Length 0.76 mm; height 0.37 mm.

Antennule 5-jointed. Ultimate podomere short and narrow with 2 elongated claws, penultimate podomere with 2 posterior claw-like setae. Second podomere with single elongated seta. First podomere consists of bristles. Antenna consisting of 3 podomeres. Ultimate podomere short, bearing two posterior claw-like setae, penultimate or second podomere broad and long and bearing 3 posterior claw-like setae and single small seta. Exopodite (spinning bristle) 2 jointed and reaching the distal ends of claws. Mandible with 2 rows of 6 serrate teeth laterally placed on cutting area. Palp 3-jointed. First segment bulbous, second segment elongate with 2 elongated setae; third segment short, bears 5 terminal bristles. Maxilla with three broad masticatory lobes, each ending in numerous setae. First thoracic leg 3 jointed. First podomere bears single anterior bristle, second podomere bears 2 anterior bristles, ultimate podomere bears single anterior bristle ends with elongated claw. First thoracic leg smaller than other two. Second thoracic leg smaller than third thoracic leg and the first podomere bears single bristle. Second podomere twice the length of the remaining podomeres. The ultimate podomere ends with strong elongated claw. Third thoracic leg 3 jointed. First podomere bears single anterior and 2 posterior bristles. Second podomere long and narrow and bears elongated setae. The ultimate podomere consists of 3 posterior bristles and ends with elongated claw.

Remarks: In the general shape, arrangement of radial pore canals, hingement and marginal area *Neomonoceratina indica* resembles *N. kutchensis* Guha, 1961 and *N. microreticulata* Kingma, 1948, *N. oertlii* Guha, 1967, *Neomonoceratina* sp. Guha *et al.* 1965, *N. bataviana* Brady, 1867, *N. iniqua* Brady, 1867, *N. rhomboideum* Brady, 1867, *N. entomon* Brady, 1890, *N. macropora* Kingma, 1948. But it differs from *N. mediterranea* Ruggieri, 1953 in the straight and simple marginal pore canals. It also differs from all the above species by the presence of 2 prominent vertical ridges on the surface of the carapace.

Type-locality: Vasishta Godavari estuary, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the Museum of Zoological Survey of India, Calcutta, India.

Occurrence: Vasishta Godavari estuary and Bimili backwater, East coast of India.

Neomonoceratina spinosa sp. nov.
(Pl. 1, Fig. E; Pl. 2, Figs. 4, 5)

Carapace sub-rhomboidal in lateral view, the height generally equals more than the half the length. The anterior end rounded with spines. There is a very pronounced caudal process in the ventral half of the posterior end. Dorsal margin straight in the left valve, sinuous in the right valve, surface of the carapace sculptured with prominent spines. Hinge amphidont type, no crenulate tooth in the posterior socket, the median hinge bar crenulate in left valve, smooth in the right valve. Inner lamella moderately wide, marginal pore canals straight and simple. Normal pores moderately few, small, scattered and open. Muscle scars in the form of vertical row of 4 adductor scars. Eye spots absent. Left valve slightly larger than right.

Length 0.59 mm; height 0.30 mm.

Remarks: In the general shape, arrangement of radial porecanals, hingement and marginal outline *Neomonoceratina spinosa* resembles *N. kutchensis* Guha, 1961, *N. microreticulata* Kingma, 1948, *N. oertlii* Guha, 1967,

Neomonoceratina sp. Guha *et al.*, 1965, *N. bataviana* Brady, 1867, *N. iniqua* Brady, 1867, *N. rhomboideum* Brady, 1867, *N. entomon* Brady, 1890 *N. macropora* Kingma, 1948 and *N. indica* sp. nov. But it markedly differs from the *N. mediterranea* Ruggieri, 1953 in the straight and simple marginal porecanals. It differs from all the above species by the presence of prominent spinose structures on the carapace. This species is named after the presence of the characteristic spinose structures on the carapace.

Type-locality: Bimili backwater, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the Museum of Zoological Survey of India, Calcutta, India.

Occurrence: This species is represented at Bimili backwater, East coast of India.

Genus: *Eopaijenborchella* Keij, 1967

Eopaijenborchella subcaudatum sp. nov.
(Pl. 1, Fig. F; Pl. 2, Figs. 6, 7)

In lateral view the carapace is ovate, wedge or pear shaped. There is a very pronounced caudal process in the ventral half of the posterior end. Anterior end broadly rounded. Dorsal margin with well marked posterior cardinal angle. The surface of each valve is traversed vertically by a deep sulcus. Inter costal areas pitted. Innerlamella moderately wide. Line of concrescence and inner margin coincide throughout and run subparallel to the outer margin. Marginal pore canals straight, simple, widely spaced. Hinge — all elements crenulate. Normal pores moderately numerous, scattered, small, open. Central muscle scars unknown. Eye spot absent. Left valve larger than the right.

Length 0.52 mm; height 0.34 mm.

Remarks: The present form differs from *Eopaijenborchella coeaenica, E. indica, E. mohani, Eopaijenborchella* sp., as illustrated by Khosla, 1967 in having an ovate to wedge shaped to pear shaped carapace, caudal process pronounced, pits arranged in lines, marginal pore canals simple and straight, hinge elements crenulated. The species is named after the pronounced caudal process.

Type-locality: Bimili backwater, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the Museum of Zoological Survey of India, Calcutta, India.

Occurrence: Bimili backwaters, East coast of India.

ACKNOWLEDGEMENTS

Thanks are due to Andhra University, Waltair for the facilities provided, to Mr. M. Ananda Rao and Prof. M. Subbarao, Geology Dept. for their help in confirming the identity of species. Finally C. A. thanks the C.S.I.R., New Delhi for financial assistance.

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MECISTOCERUS MONUBUMENSIS SP. NOV. (COLEOPTERA: CURCULIONIDAE: CRYPTORHYNCHINAE) FROM INDIA[1]

LEHNA SINGH ARYA[2] AND H. R. PAJNI[3]

(*With three text-figures*)

INTRODUCTION

The genus *Mecistocerus* Fauvel is so far represented by nine species from India (Hustache 1936), among these five, *M. cristatus, M. petruelis, M. nigropunctatus, M. geniculus-albis* and *M. nigrostriatus* have been reported from Andaman Islands (Chevrolat 1884). Thus, only four species have so far been described from the mainland, and of these two, *M. ricini* and *M. fumosus* (Marshall 1921, 1933) were recorded from United Province (Uttar Pradesh) and the remaining two *M. simplex* (Faust 1898) and *M. fossatifrons* (Marshall 1936) were described from eastern India and Kalimpong, in North West Bengal respectively. It is, therefore, apparent that only one species *viz., M. simplex* Faust has been reported from Eastern Himalayas from where this new species is recorded.

DESCRIPTION

Head black, coarsely and reticulately punctate, clothed with pale recumbent overlapping scales forming an arc in front; *frons* with deep, elongate, bare sulcus; *eyes* shiny-white, latero-ventral, ovate. *Rostrum* piceous in basal half, ferruginous in apical half, tricarinate in one fourth basal region, punctate prominently in three fourth basal region, scattered and inconspicuous in remaining, furnished with sparse suberect scales in closely punctate region, with setae elsewhere. *Antennae* ferruginous, inserted in middle; funicle pubescent, with segment 1 as long as 2, 3-6 moniliform, 7 transverse; club subconical, with first two joints subequal. *Pronotum niger,* longer than broad, broadest and truncate at base, parallel-sided in basal three fourth region then gradually narrowing towards apex, without subapical constriction, longitudinally convex, coarsely and reticulately punctate with each puncture accommodating horizontal foliaceous scale and intervals furnished with erect setae except api-

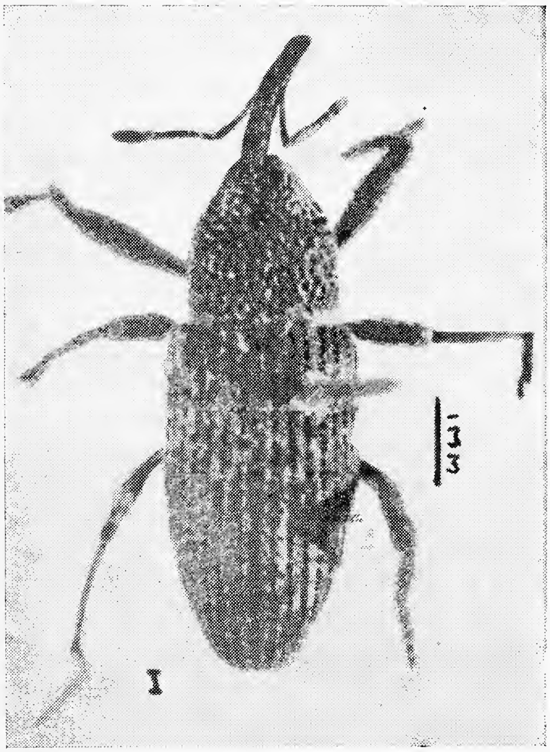

Fig. 1. Adult of *Mecistocerus monubumensis* sp. nov.

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cal region clothed with dense scales. *Scutellum* black, triangular, impunctate, bare. *Elytra* piceous, broader than base of pronotum, oblong-ovate, with roundly rectangular humeri; strial punctures each accommodating horizontal seta; intervals as broad as striae almost flat except interval 4 and 5 rugulose and granulate at base, furnished with black and pale oblong scales as well as each with row of pale erect setae; *vestiture* black variegated with light-yellow scattered patches and bands of which two-one in middle other on declivity, conspicuous. *Legs* with femora black, closely punctate, densely clothed with grey scales interspersed with setae, hind femora with a small fulvous patch at posterior extremity; tibiae curved at base, feebly bisinuate ventrally, with a black patch at base, densely clothed with greyish scales as well as setae in apical half, amucronate. Sternal canal ending just behind hind end of midcoxae.

Abdominal sternites coarsely punctate, furnished with greyish recumbent scales as well as setae at both punctures and interspaces.

Male genitalia with aedeagus slightly curved inwardly, broader at both ends tapering towards middle, more sclerotized laterally; aedeagal apodemes longer than aedeagus, approximate at base becoming gradually farther behind; endophallus studded with cellular granules forming sheets; phallotreme subapical, slit like; phallobasic ring complete, weakly sclerotized; phallobasic apodeme rather small; parameres median, separate. Spiculum gastrale with median arm strongly sclerotized, uniformly tubular; lateral arms subequal, as sclerotized as median.

Measurements: Body length 6.2-6.56 mm; Body width 1.84-2.14 mm; Rostrum length 1.88-2.0 mm; Rostrum width 0.28-0.35 mm.

Specimens Examined: *Holotype*: Male, Arunachal Pradesh: Monubum; tube light, PL-480 project Coll.; 24.vi.1977. *Paratype*: Male; data same as that of holotype.

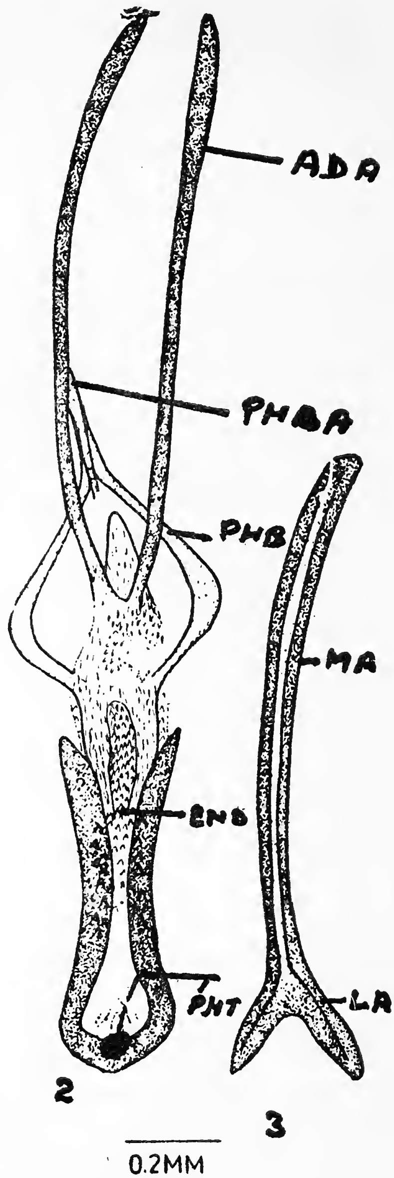

Fig. 2. Male genitalia of *M. monubumensis*; Fig. 3. Gastral spiculum of *M. monubumensis*.

Abbreviations

ADA — Aedeagal apodeme; END — Endophallus;
LA — Lateral arm; MA — Median arm;
PHB — Phallobase; PHBA — Phallobasic apodeme;
PHT — Phallotreme.

Type Depository: Entomological Museum, Forest Research Institute, Dehradun (U.P.), India.

Remarks: The species can be readily distinguished from other Indian species by its narrow and elongate body. It is also the only species that bears a row of erect setae on each interval of the elytra. Besides, the body is devoid of scales but for a few scattered patches and two oblique scaly bands-one in middle and the other on the declivity of the elytra.

ACKNOWLEDGEMENTS

We are thankful to the Ministry of agriculture, United States of America for sanctioning the project in which senior author has been the Research Scholar; to Dr. P. K. Sen-Sarma, Director, Biological Research, F.R.I., Dehra Dun (U.P.) for allowing the comparison of the material with identified material of his museum. The facilities provided by the Chairman, Department of Zoology, Panjab University, Chandigarh are duly acknowledged.

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CONTRIBUTION TO THE KNOWLEDGE OF DESMIDS OF INDIA — SOME NEW TAXA FROM KARNATAKA STATE[1]

G. R. HEGDE[2]

(*With five text-figures*)

INTRODUCTION

Extensive collections from freshwater ponds and lakes of Shimoga District in Karnataka State (India) were made during Nov.-Dec. 1978. This district extends between 13°17′ & 14°39′N latitude and 74°38′ & 76°04′E longitude. The average temperature varies from 9°C to 38°C and the rainfall reaches 8275 mm in the region of Agumbe, which is known as the southern Chirapunji. The samples collected contained five new taxa of desmids and are described.

(Following abbreviations are used in the text: L = Length; W = Width; I = Isthmus and T = Thickness.)

Closterium prescottii sp. nov. (Fig. 1).

Cellulae fusiformes, cingulo medio praeditae, *c.* 10 plo longiores quam latae; margines laterales fere rectissimi a loco prope centrum ad polos angusta rotundatos; membrana interior incrassata ad polos; membrana cellularis 10-14 strias praebens.

Iconotypus: Fig. 1.

[1] Accepted September 1985.

[2] Algal Laboratory, P. G. Department of Botany. Karnatak University, Dharwad-580 003.

Locus typi: Ikkeri (Sagar).

Cells spindle shaped with median girdle band; about 10-11 times longer than wide; lateral margins almost perfectly straight from near the center to the narrowly rounded poles, inner wall thickened at the poles; cell wall with 10-15 striations. L 868 μm; W 67 μm; W pole 8 μm.

Iconotype: Fig. 1.

Distribution: Ikkeri (Sagar).

Closterium shimogaense sp. nov. (Fig. 2)

Cellulae fere rectae, *c.* 14 plo longiores quam latae, margines laterales utrimque paululo inflati; membrana cellularis 10-15 strias praebens; poli fere plani.

Iconotypus: Fig. 2.

Locus typi: Shimoga.

Cells almost straight, about 14 times longer than wide, lateral margins slightly inflated on both the sides; cell wall with 10-15 striations; poles almost flat. L 760 μm; W middle 55 μm.

Iconotype: Fig. 2.

Distribution: Shimoga.

Pleurotaenium verrucosum (Bail.) Lund. var. **validum** Scott et Grönbl. fa. **irregularis** fa. nov. (Fig. 3).

Varietas magnitudine varietati similis. Differens ut granuli polares plures, area infra polos ut videtur levis, areae incrassatae ambitu irregulares, areae tenues granulationes praebentes. Semicellulae paululum curvatas.

Iconotypus: Fig. 3.

Locus typi: Tyarendur.

Similar to the variety (Scott and Prescott 1961, pl. 5, fig. 9, p. 20) in size. Differs in having more number of polar granules; area below the poles apparently smooth; thickened areas irregular in outline, thin areas show granulations. Semicells slightly curved. L 445 μm; W 51 μm; I 46 μm; W pole 35 μm.

Iconotype: Fig. 3.

Distribution: Tyarendur.

Cosmarium miyajimense Hinode var. **papillatum** var. nov. (Fig. 4).

Varietas magnitudine formaque speciei similis, differens ut pori pauciores maioresque. Superficies papillam subapicalem obtusam habens. Isthmus comparate angustior.

Iconotypus: Fig. 4.

Locus typi: Agumbe.

Similar to the species (Hinode 1977, figs. 12 & 13, p. 84) in size and shape. Differs in having fewer and bigger pores. Surface with subapical blunt papillum. Isthmus comparatively narrower. L 21-22 μm; W 21-22 μm; I 3-4 μm; T 9-10 μm.

Iconotype: Fig. 4.

Distribution: Agumbe.

Staurastrum galeatum Turner var. **verrucosum** var. nov. (Fig. 5).

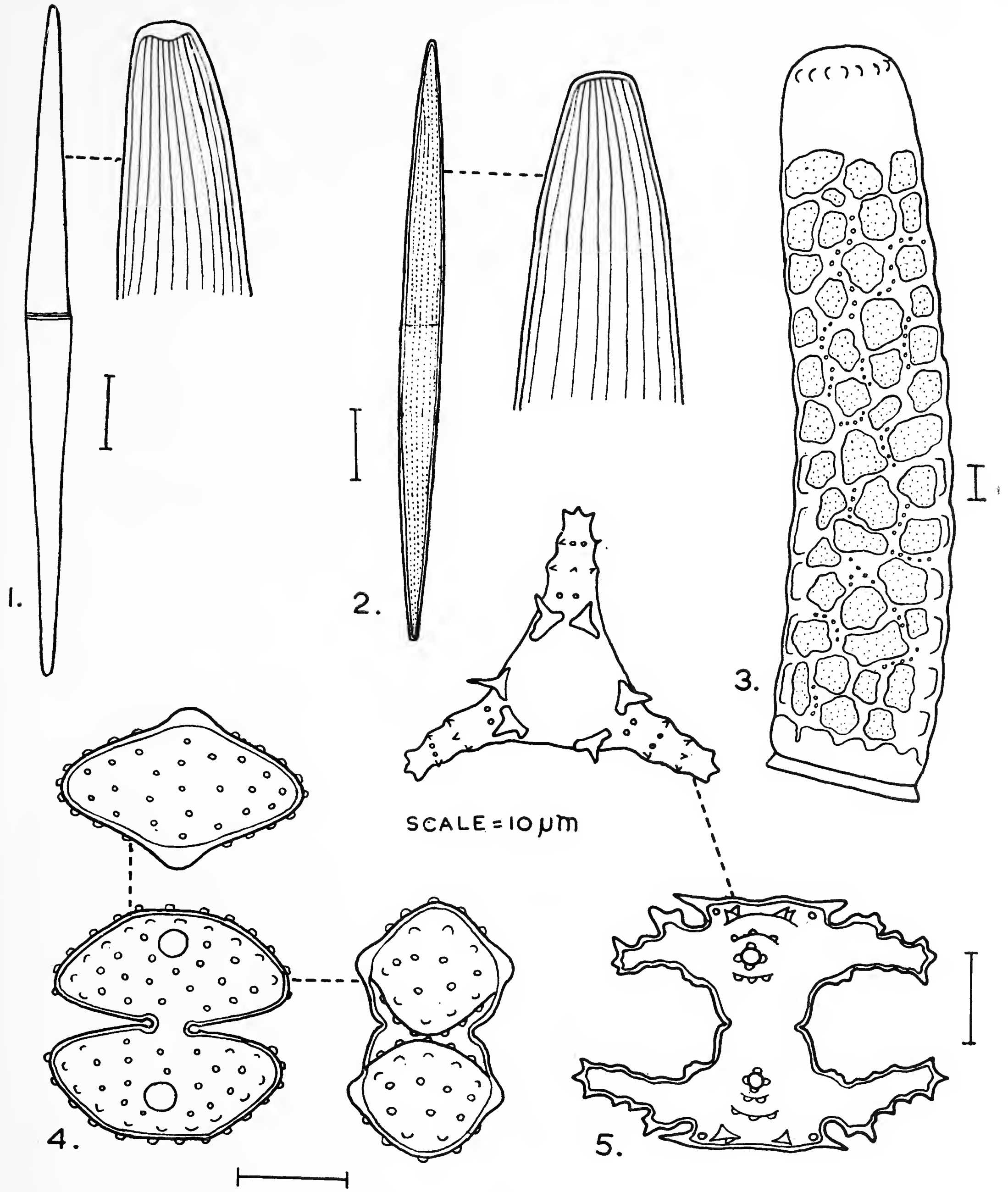
Varietas magnitudine speciei similis; differens processibus paululo brevioribus, crassis atque paululum incurvatis. Omnis processus verruca juxta basim in latere ventrali praeditus. Processus, speciei dissimiles, in 4 spinas terminantes. Verrucae in latere processuum dorsali, ad basim, comparate breviores. Semicellula a vertice visa triangularis anulum centralem verrucarum 3 spinis praeditarum praebens.

Iconotypus: Fig. 5.

Locus typi: Bharatipura (Agumbe).

Size similar to the species (Hirano 1959; pl. 52, fig. 4, p. 382) differs in having slightly shorter stout and slightly incurved arms. Each arm with a verruca near the base on ventral side. Unlike the species, arms end in 4 spines. On dorsal side of arms, near the base, the verrucae are comparatively shorter. Vertical view triangular with a central ring of verrucae having 3 spines. L 28-30 μm; W with arms 40-42 μm; I 7-8 μm.

Iconotype: Fig. 5.



Figs. 1-5.

1. *Closterium prescottii* sp. nov.; 2. *Closterium shimogaense* sp. nov.; 3. *Pleurotaenium verrucosum* (Bail.) Lund. var. *validum* Scott *et* Grönbl. fa. *irregularis* fa. nov.; 4. *Cosmarium miyajimense* Hinode var. *papillatum* var. nov.; 5. *Staurastrum galeatum* Turner var. *verrucosum* var. nov.

Distribution: Bharatipura (Agumbe).

Summary

Five new taxa of desmids (Chlorophyceae) collected from freshwater ponds and lakes of Shimoga district (Karnataka State) during Nov.-Dec. 1978 are described.

Acknowledgements

Thanks are due to Dr. G. W. Prescott for his critical observations and suggestions. Thanks are also due to Dr. Hannah Croasdale for rendering the Latin diagnoses of the new taxa. I am grateful to Prof. S. G. Bharati, P. G. Department of Botany, Karnatak University, Dharwad for the encouragement.

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DASINEURA PSORALEAE (DIPTERA: CECIDOMYIIDAE) — A NEW GALL-MIDGE, INFESTING INFLORESCENCES OF *PSORALEA CORYLIFOLIA* LINN.[1]

R. M. Sharma[2]

(*With thirteen text-figures*)

A new species of gall-midge, *Dasineura psoraleae* infesting the inflorescence of *Psoralea corylifolia* Linn. (Leguminosae) from Aurangabad (Maharashtra has been described and illustrated.

Genus *Dasineura* Rondani is represented in India by six species, Grover (1981). In November 1979 a large number of midges were bred from the inflorescence of *Psoralea corylifolia* Linn. at Aurangabad (Maharashtra) and were determined as assignable to the genus *Dasineura*. This midge is distinguished from the known species by many morphological characters. It does not cause any marked galls on the flower buds. The larvae fed on the ovary of the buds which ultimately fail to produce legumes. The larvae pupate in the flower-bud and not in the soil.

[1] Accepted July 1985.

[2] Zoological Survey of India, Western Regional Station, Pune - 411 016, India.

[3] Numbers in parentheses indicate length and breadth proportions, measured with the help of an oculometer.

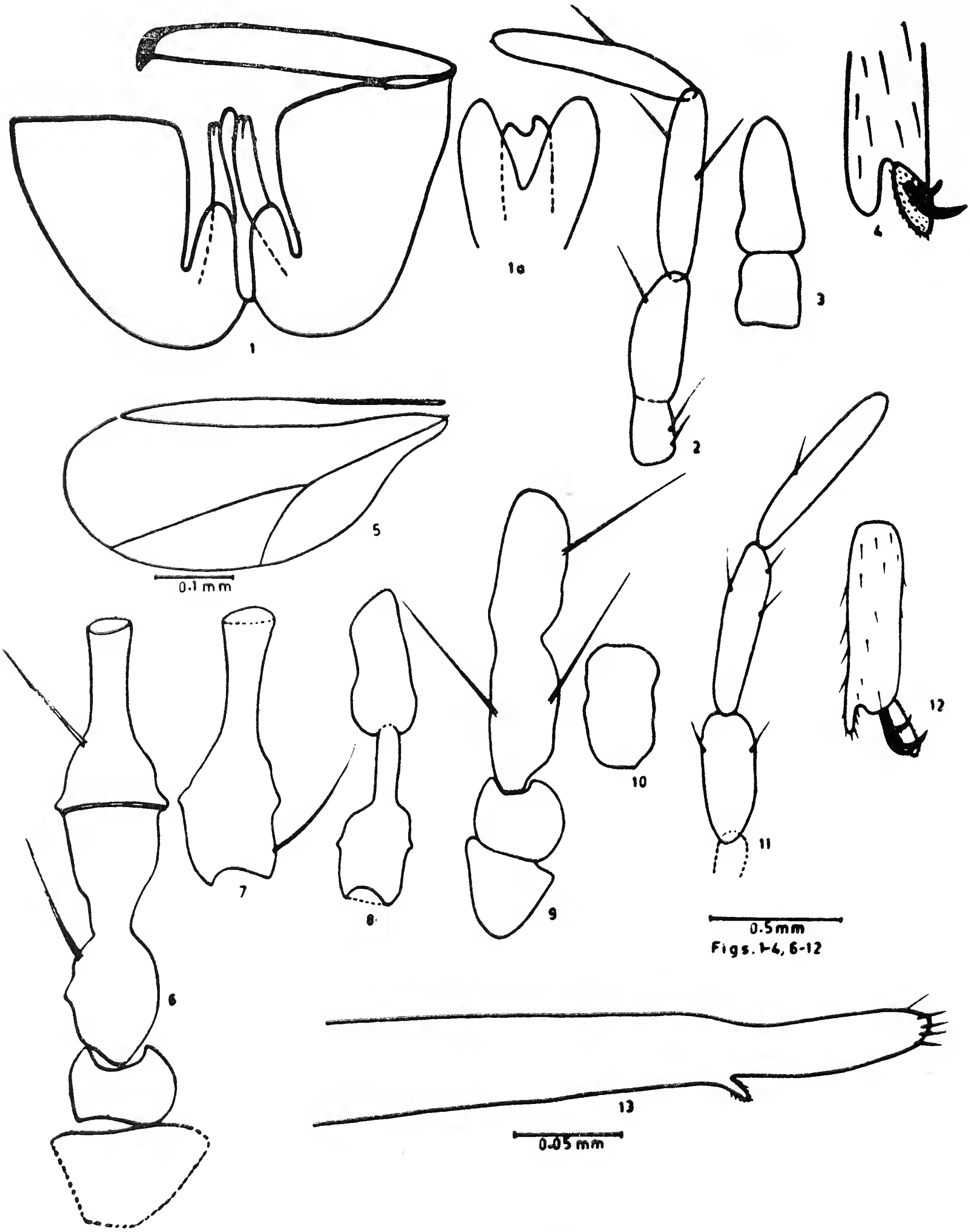
Dasineura psoraleae sp. nov. (Figs. 1-13)

MALE: Body 1.91 mm long, yellowish-brown; eyes confluent above; trophi normal; palpus 4-segmented, moderately long, sparsely setose; first segment (9:6)[3] cylindrical, length 1.50 × its maximum thickness; second segment (19:8) cylindrical, length a little more than 2.37 × its maximum thickness; third segment (27:6) cylindrical, longer and thinner than second, length 4.50 × its maximum thickness; fourth segment (30:5) cylindrical, longest and thinnest of all, 6.00 × as long as thick. *Antenna*: shorter than body with 2 + 12 to 2 + 14 segments (2 + 13 in holotype), segments with cylindrical enlargements and long apical stems; enlargements with a whorl of long setae, circumfila ring-like; scape (14:21) cup-shaped, wider than long; pedicel (13:14) subglobose;

third segment (26) confluent with and shorter than fourth, with a very small basal prolongation; enlargement (16:12) 0.61 the length of the segment and 1.33 × its maximum thickness, stem (7:6) 0.43 the length of the enlargement and a little less than as long as wide; fourth segment (37) with enlargement (21:22) 0.56 the length of the segment and 1.75 × its maximum thickness, stem (16:5) 0.76 the length of the enlargement and a little more than 3.00 x its maximum thickness; fifth segment (37) as long as and similar to the fourth, except apical stem (17) a little longer than the stem of the fourth segment; 6-13th segments gradually becoming shorter and thinner; penultimate segment (23) with an enlargement (13:10) 0.56 the length of the segment and 1.30 × its maximum thickness; stem (10: 3) 0.77 the length of the enlargement and 3.33 × its maximum thickness; terminal segment (19:8) shortest of all, conical, length a little more than 2.37 × its maximum thickness. *Wing*: (53:24) hyaline, 2.20 × as long as broad, costa sparsely hairy, vein R_1 joining costa a little beyond 0.25 the length of the wing; vein R_5 reaching costa well before the wing apex, interrupted at its union with the latter, vein *C*u forked. *Legs* long, moderately hairy, metatarsus (9) as long as terminal tarsal segment, second tarsal segment (72) longest of all, longer than the following segments combined together (65); claw (6) dentate on all legs, evenly curved, empodium shorter or as long as claw (10:10). *Genitalia*: light brown, sparsely setose, basal clasp segment (41:21) enlarged apically and narrowed basally with a heavily setose cylindrical, elongated basal lobe, length nearly 2.00 × its maximum width, shorter than terminal clasp segment, later (45:6) slender evenly narrowed, ending in a dark pointed tooth, length 7.50 × its maximum thickness; dorsal plate (20:20) as long as broad, deeply bifid, setose, tips rounded; subdorsal plate (17:9) shorter and narrower than dorsal plate, nearly 2.00 × as long as broad, shallowly notched in the middle, setose, lobes narrowly rounded apically; parameres bilobed, shorter than aedeagus, each lobe cylindrical, beset with fine setae laterally; aedeagus (28:2) rounded apically longer than dorsal and subdorsal plates, length 14.00 × its maximum thickness.

FEMALE: Body 1.56 mm long (including ovipositor). *Palpus*: 4-segmented, first segment short not distinct in the preparation; second segment (17:7) cylindrical, length 2.43 × its maximum thickness; third segment (23:6) longer and thinner than second, length nearly 4.00 × its maximum thickness; fourth segment (27:6) cylindrical, longest of all, 4.50 × as long as thick. *Antenna*: 0.33 the length of the body with 2 + 11 to 2 + 13 cylindrical, sessile segments, segments with a whorl of long setae, circumfila low; scape (11:12) cup-shaped; pedicel (11:13) subglobose, wider than long; third segment (21) confluent with and as long as fourth, enlargement (19:9) slightly more than 2.00 × its maximum thickness; fourth segment similar to the third; fifth segment (16: 9) shorter than fourth, 1.77 × as long as thick; distal segments gradually becoming shorter, penultimate segment (10:9) shortest of all, nearly as long as thick; terminal segment (17: 9) conical, longer than penultimate, length nearly 2.00 × its maximum thickness; wing, legs and claw as in male. *Ovipositor*: exserted, protractile, nearly as long as abdomen, terminal lobe (24:6) elongate, length 4.00 × its maximum thickness, tip beset with a few setae; ventral lobe very small.

Holotype ♂, *Allotype* ♀ and *Paratypes*: 6 ♂♂, 6 ♀♀ all dissected and mounted on slides ex inflorescence of *Psoralea corylifolia* Linn. Himayat Bagh, Aurangabad, India, 13.xi.1979, Coll. R. M. Sharma, (Many ♂♂ and ♀♀ in alcohol). All types are de-



Figs. 1-13. *Dasineura psoraleae* sp. nov.

1. Genitalia (Dorsal view) ♂; 1a. dorsal and subdorsal plates ♂; 2. palpus ♂; 3. terminal antennal segments ♀; 4. claw ♂; 5. wing ♂; 6. scape, pedicel, third and fourth antennal segments ♂; 7. fifth antennal segment ♂; 8. terminal two antennal segments ♂; 9. scape, pedicel, third and fourth antennal segments ♀; 10. fifth antennal segment ♀; 11. palpus ♀; 12. claw ♀; 13. ovipositor ♀.

posited in the collections of Zoological Survey of India, Pune, for the time being.

Sex-ratio: ♂ : ♀ = 32:48 (i.e., 38.75% ♂). This species is univoltine.

Parasites: Three different unidentified chalcid parasites were reared along with the midges.

Remarks: This species comes very close to *D. sesami* Grover and Prasad (1966) but differs in the number, length and proportions of antennal segments; empodium as long as claw; basal clasp segment with cylindrical basal lobe; aedeagus tip rounded; ovipositor half the length of the body and dorsal lamella 4.0 × as long as broad.

ACKNOWLEDGEMENTS

I am grateful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta and the Officer-in-charge, Zoological Survey of India, Pune for facilities. I am also thankful to Prof. S. N. Rao (Retd.), Department of Zoology, Marathwada University, Aurangabad for his keen interest in my studies on Indian gall-midges.

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OBITUARY

S. P. SHAHI
(1917-1986)

The ranks of conservationists in India lost one of its outstanding members, a year ago, in the passing away of Suresh Prasad Shahi on 23 April 1986, at Ranchi.

S. P. Shahi was born on 10th March 1917 at Muzaffarpur in Bihar. He joined the Bihar Forest Service in 1942 and became the Chief Conservator of Forests at the age of 43 in 1960 — the youngest ever to do so in the country. His tenure of 15 years as the CCF is perhaps one of the longest. Like many of us, he saw the light and turned from the gun to camera, recalling his hunting days with remorse and regret. Some of the outstanding pictures taken by him during his last five years in the service, may be seen in his book, BACK TO THE WALL, which he dedicated to "his erstwhile colleagues .... with the fervent hope that they will preserve and enrich for posterity the priceless trust in their charge — Wildlife".

His contribution to the development of the crocodile breeding project in Bihar, the establishment of the tiger reserve in Palamau and various other sanctuaries are among some of the notable achievements. Even after his retirement he continued his attempts to extend conservation measures to the wetland areas in North Bihar, especially the Kawar Lake in Begusarai District.

He worked actively for the conservation of nature and natural resources, long after his retirement even though he had a heart problem. He was the only wildlifer who was invited as a special guest in some meetings of the Steering Committee of Project Tiger. He was the senior member of an Expert Committee which studied the man eating problem in Kheri District of U.P. and in the Sunderbans Tiger Reserve, which helped a great deal in formulating the practical strategy for solving this problem.

He was the Co-ordinator of the Central India Task Force of the Asian Elephant Group, set up by the Species Survival Commission (SSC) of the International Union for Conservation of Nature and Natural Resources (IUCN). He carried out extensive status surveys and his final report contains many recommendations for elephant conservation and the creation of additional sanctuaries.

He was a member of the Wolf Group of the SSC and attended their meetings in the USA and Sweden. His paper, on the status of the wolf in India was greatly appreciated.

He contributed a number of articles on conservation in newspapers and magazines, in India and abroad. His slide illustrated talks to the young participants of nature education camps will be long remembered.

He was a member of the Indian Board of Wild Life (IBWL) both during his service and after his retirement. He passed away in harness, for he attended a meeting of the Standing Committee of the IBWL only a few days earlier, in New Delhi.

To quote Dr. M. K. Ranjitsinh — "he was amongst the foremost of the foresters of the day who regarded nature conservation and forest and wildlife preservation as a major integral task of a forest officer's duties. He was in many ways an example to forest officers who, despite the fact that they were keen on nature conservation, were at that point of time unable to find an identity of their own in the set-up, of the department throughout the country".

JACK SAWHNEY

REVIEWS

1. ANNOTATED CHECKLIST OF THE BIRDS OF HONG KONG. By M. L. Chalmers. 4th Edition. pp. 279 (21.5 × 15 cm), with many illustrations and black-and-white photographs. Hong Kong, 1986. The Hong Kong Bird Watching Society. Price not mentioned.

This is the fourth edition of the Checklist of the Birds of Hong Kong (the first published in 1960), all being revised or rewritten by different persons. It covers 784 species on 270 pages and deals in some detail with the status, general abundance, and if migrant gives the first and last dates together with a histogram showing frequency of occurrence in different months and when marked resident have a further break-up into possible, probable, and confirmed breeders.

The area covered extends over a thousand square kilometres and includes some 200 islands. The bibliography includes over 500 titles and judging by names and language of writing are almost entirely by Englishmen or Americans. The compilation has indeed been a laborious piece of work and an example of the checklist which can be an excellent guide to the beginner and tell him at a glance the relative value of his observation and decide which one would be worth offering for publication.

Collections have no doubt been made in the area but there is nothing to show the total number collected and their availability for checking upon the correctness of the identification.

H. ABDULALI

2. THREATENED ANIMALS OF INDIA. By B. K. Tikader. pp. 307 (24 × 17 cm), with 125 coloured plates, 56 maps and a text-figure. Calcutta, 1983. Zoological Survey of India. Price Rs. 150.00, $ 45, £ 25.

This book on the endangered animals of the Indian fauna was commissioned by the Department of Environment. It briefly discusses the status of 146 species of mammals, birds and animals selected from Schedules I to IV of the Indian Wild Life (Protection) Act. Species believed to be extinct are included, of which one, the Jerdon's Courser, has happily been rediscovered since the publication of this book. The peacock is included, although it certainly should not figure on the danger list and is protected, in Schedule I, principally because it is India's national bird. There are distribution maps for some of the species and colour plates (unnumbered) for most of them. While some of the illustrations are from photographs taken by the author, many, particularly those of the birds, have been borrowed from other publications, apparently without acknowledgement. None of the information is particularly new, but it is useful to have it collected in a single volume, together with annexures which include notes on the constitution of the Indian Board for Wild Life, the Indian Wild Life (Protection) Act, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. (CITES)

If, as the author implies in his foreward, this book is meant to interest lay readers, its

style is rather too dry and official. Anecdotes, such as the dramatic reappearance of the Pigmy Hog and the Hispid Hare in Assam, when these species were believed to be extinct, could have been used with effect. Since this book comes from the Zoological Survey of India, one would have expected some reference to the fact that the official danger list is relatively haphazard because our knowledge of the current status of species of certain groups is simply inadequate. Fresh water fish and bats for instance do not figure except that fruit bats are classified as vermin in Schedule V., without knowing to what extent they are responsible for pollination, crossfertilisation and dispersal of different trees both cultivated and indigenous. Yet what do we about populations of insectivorous bats, which must be threatened by the increased use of agricultural pesticides? The status of invertebrate species for example butterflies, like the spectacular bird-wings of Assam, needs to be reviewed. One hopes that the Zoological Survey has some of these issues under examination for future editions.

R. REUBEN

3. THE USEFUL PLANTS OF INDIA. Edited by S. P. Ambastha, Kamala Ramachandran, K. Kashyapa and Ramesh Chand. pp. 918 (22 cm. × 15 cm.), New Delhi, 1986. Publications & Information Directorate, CSIR. Price Rs. 128/- Or $ 32 Or £ 24.

This is a concise edition of 'Wealth of India — Raw materials' giving botanical names, synonyms, vernacular names and their utilities. The book is more or less planned on the format of CSIR's earlier excellent and well received publication, "Glossary of Indian Medicinal Plants (1956)" and its supplement (1969), by Chopra *et al.*

There are a few additions as compared to the list of plants given in the 'Glossary and its supplement' and many synonyms and vernacular names have been added. However a number of entries on plants given in the glossary have been deleted making it more or less incomprehensive. This volume lacks the excellence of a scientific report because it does not quote the earlier references for the utilities and related information. It also lacks in pharmacological and phytochemical data as well as excludes distribution of the species.

Nomenclature of plants in some cases requires correction in modern terms of their taxonomical concepts, e.g. *Messua ferrea* Linn. (= *M. nagassarium* (Burm. f.) Kosterm.), *Zanthoxylum limonella* (Dennst.) Alston (= *Z rhetsa* (Roxb.) DC.), *Hydnocarpus laurifolia* (Dennst.) Sleummer (*H. pentandra* (Ham.) Oken.), *Wagatea spicata* Dalz. (=*Moullava spicata* (Dalz.) Nicolson), etc.

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. GROUP NUMBER AND COMPOSITION OF HANUMAN LANGUR (*PRESBYTIS ENTELLUS*) IN JAIPUR, INDIA

(*With a text-figure*)

Introduction

Langurs and rhesus are commonly seen in most of the north Indian cities. There are very few long term, behavioural and demographic studies conducted systematically on any one population (Mohnot 1968, 1971, 1974, 1975, 1978, 1980; Mohnot *et al.* 1981) or on different populations (Southwick 1960, 1980; Southwick *et al.* 1961, 1980; Southwick and Siddiqui 1966, 1968, 1970, 1977), and even fewer studies on urban monkeys (Singh 1966).

The present investigation, therefore, was taken up for two main reasons (i) to add some basic information about primate population, and (ii) to collect baseline data for future comparative behavioural, demographic studies, particularly of langurs occupying different habitats.

Methods

Jaipur, our research site, is the capital city of the state of Rajasthan in India. It is situated amidst the Aravali hill ranges at an altitude of 430 m above mean sea level, and lies on latitude 26°55′N, and longitude 75°50′E. The region is semi-arid and moderately vegetated, with 600 mm average annual rain fall. Maximum temperature is 46°C during June and minimum is 6°C in January. Humidity is 80% during monsoon months.

Jaipur city has two parts, old city and outskirts (Fig. 1). The population survey of langurs was started in May 1985 with the collection of verbal information from the local people, roadside shop keepers and from areas which are known to have monkeys. For this, a road survey was launched using scooter and jeep during early morning hours once in a week covering 20 km/trip at various routes. Repeated travelling and verbal information helped in locating groups. Location of each group was marked on the map and the local people were interviewed to know more about that group. After this, each group was visited for 5-8 consecutive days for its identification, group type, and to count the total number of individuals in different age-sex classes.

The counting was done either (i) early morning when monkeys are most clearly seen leaving their roosting site in almost single file or (ii) during afternoons and evenings by feeding and attracting monkeys with peanuts and gram seeds.

On an average, individuals of each group were counted for 10-20 times. The individuals of each group have been classified into age-sex classes *viz.*: adult male, adult female, sub-adult male, sub-adult female, juvenile, infant I and infant II.

Results

During the past twelve months, 25 groups of langurs have been located, identified, followed for their group identification and other details of the group. The surveyed area included

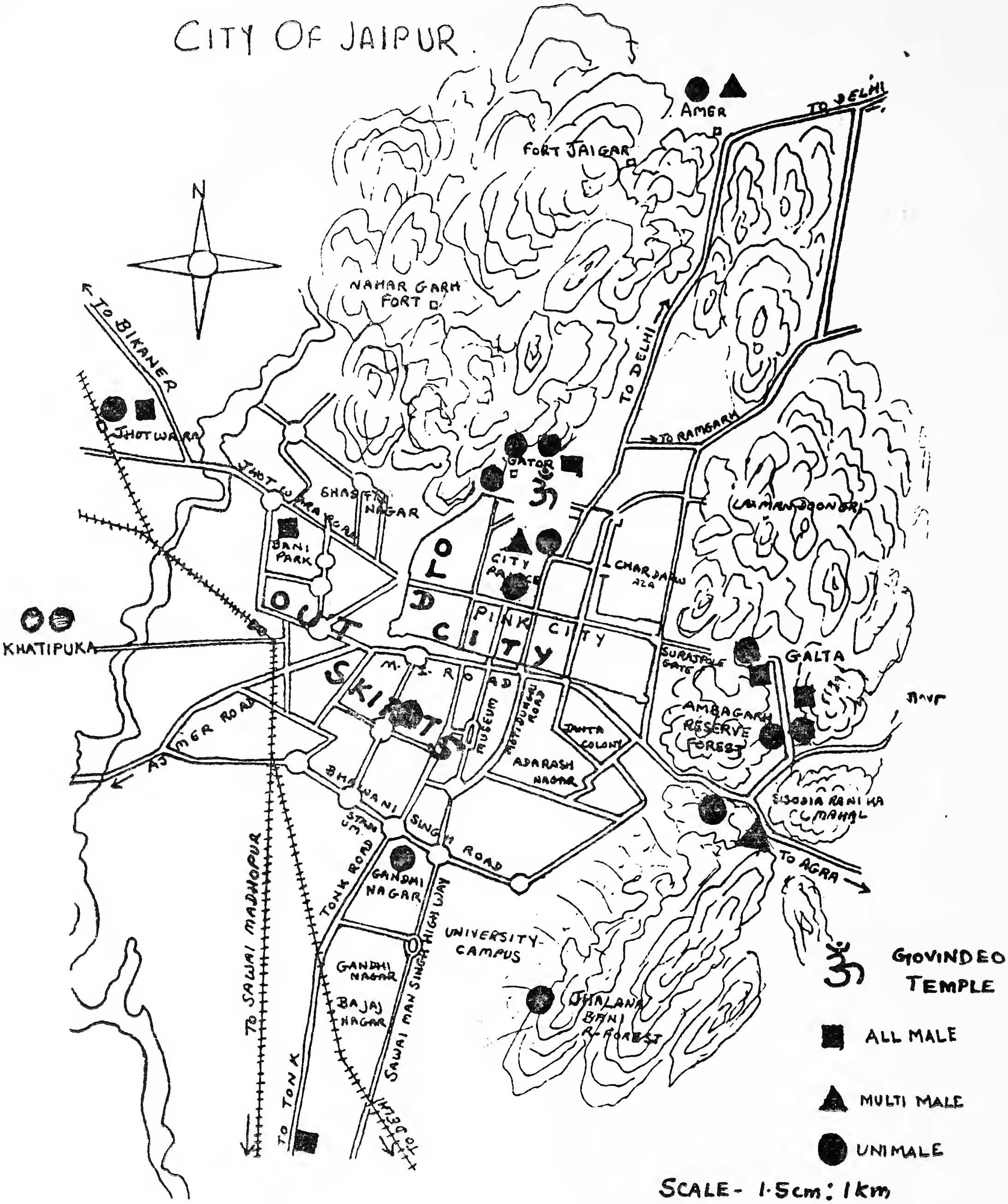

Fig. 1. Jaipur, old city and outskirts.

old city (less number of trees, markets of grains, vegetables, fruits, jaggery, presence of temples, palaces, gardens and residences) and outskirts (more trees; generally offices and residences).

Out of 25 groups only six langur groups are found in old city, otherwise, they seem to prefer the outskirts of the city. The six groups in the old city rely mainly on provisioning, which they get maximum at a temple "Govindeoji" (Fig. 1). Among the six, 3 groups live in this area, whereas, 12 other groups have occupied the outskirts of the city. These 12 groups are seldom fed by human beings, on the contrary, they are considered as pests. These groups exploit a variety of plants and trees they even raid kitchen gardens. The seven remaining groups inhabit Galta area where there is heavy provisioning but they also have the chance to feed upon many plant species a few of them are mentioned in Table 1.

Out of a total of 25 there are 16 unimale bisexual groups, 6 all male groups and 3 multimale groups. There is a great variation in the group size of unimale groups; the smallest

TABLE 1

SOME TREES EXPLOITED BY LANGURS IN JAIPUR

	Species	Leaf buds	Young leaves	Mature leaves	Peteole	Bark	Flowers	Fruits
1.	*Holoptelea integrifolia*	*	*	*	*			*
2.	*Ficus bengalensis*		*	*	*			*
3.	*Ficus religiosa*		*	*	*			*
4.	*Ficus racemosa*		*	*				
5.	*Azadirachta indica*		*	*				
6.	*Dalbergia sissoo*		*	*			*	
7.	*Tamarindus indica*		*	*				
8.	*Pithecolobium dulce*		*	*				
9.	*Anogeissus pendula*		*	*	*			
10.	*Morus alba*		*	*				
11.	*Prosopis juliflora*		*	*				*
12.	*Prosopis cineraria*		*	*				
13.	*Boswellia serrata*		*	*			*	
14.	*Albizzia lebbek*		*	*				
15.	*Delonix regia*		*	*				
16.	*Dichrostachys cinerea*		*	*				
17.	*Acacia totilis*		*	*				
18.	*Acacia nilotica*		*	*				
19.	*Bauhinia variegata*						*	*
20.	*Cardia gharafi*		*	*				
21.	*Mitragyna parvifolia*							*
22.	*Manilkara hexandra*		*	*				
23.	*Tecoma stans*		*	*				
24.	*Hibiscus rosa-sinensis*		*	*				
25.	*Psidium guajava*					*		

* Part exploited.

TABLE 2

GROUP NUMBER, COMPOSITION OF UNIMALE GROUPS

Sr. No.	Place	Area	Vegetation	Degree of provisioning*	Group No.	Group Type	Adult Male	Adult Female	Infant I	Infant II	Sub-Adult Male	Sub-Adult Female	Juve-nile	Total
1.	Govindeoji Temple	Temple	Moderate	Moderate	GUM I	Unimale	1	22	1	5	–	6	7	42
2.	Jantar-Mantar	Tourist spot	Moderate	Little	JUM I	,,	1	18	3	4	–	5	5	36
3.	Amber Fort	Tourist spot	Moderate	Heavy	AUM I	,,	1	34	1	16	–	5	23	80
4.	Gaithore	Tourist spot	Moderate	Moderate	GAUM I	,,	1	22	4	7	–	2	6	42
5.	Gaithore	Tourist spot	Moderate	Little	GAUM II	,,	1	18	5	–	–	3	4	31
6.	Gaithore	Tourist spot	Moderate	Little	GAUM III	,,	1	11	–	9	–	–	6	27
7.	Jhalana	Stone Quarry	Little	Very little	JHUM I	,,	1	13	–	–	–	3	4	21
8.	Galta	Holy place tourist spot	Moderate	Heavy	G-III	,,	1	49	14	13	–	7	34	118
9.	Galta	,,	Moderate	Heavy	G-IV	,,	1	48	15	18	–	6	14	102
10.	Galta	,,	Moderate	Heavy	G-V	,,	1	35	12	5	–	3	20	76
11.	Bapu Nagar	Residential	Little	Very little	BUM I	,,	1	12	4	–	–	1	2	20
12.	'C'-Scheme	Residential	Moderate	Very little	'C' UM I	,,	1	20	2	9	–	–	4	36
13.	Jhotwara	Residential	Little	Very little	JWUM I	,,	1	10	2	2	–	2	2	19
14.	Khatipura	Temple, Forest, Nursery	Moderate	Heavy	KUM I	,,	1	53	13	28	–	2	14	111
15.	Khatipura	Picnic place, Forest, Nursery	Moderate	Moderate	KUM I	,,	1	24	8	11	–	1	9	54
16.	Vidhyadhar Bagh	Tourist spot	Moderate	Moderate	VUM I	,,	1	27	10	3	–	3	11	55
														Total: 870
														Average 54.4

* Degree of provisioning: Heavy = Every day and entire day; Moderate = every day at fixed hours; Little = Once every day; Very little = Once in a week or almost nil.

TABLE 3

GROUP NUMBER, COMPOSITION, SEX RATIO OF MULTIMALE AND ALL MALE GROUPS OF JAIPUR

Sr. No.	Place	Area	Vegetation	Degree of provisioning*	Group No.	Group Type	Male Adult	Female Adult	Infant I	Infant II	Sub-Adult Male	Sub-Adult Female	Juvenile	Total	Sex ratio
	MULTIMALE														
1.	Govindeoji Temple	Temple	Moderate	Heavy	GMM II	Multi-male	5	16	–	5	8	4	7	45	1:1.53
2.	Amber Fort	Tourist spot	Moderate	Heavy	AMM II	,,	4	13	1	3	2	2	1	26	1:2.5
3.	Sisodia Garden	Gardens	Moderate	Heavy	SMM I	,,	2	22	–	7	5	1	12	49	1:3.14
													Total:	120	Average 40.0
	ALLMALE														
1.	Gaithore	Tourist spot	Moderate	Little	GAMM IV	All-male	5	–	–	–	28	–	9	42	
2.	Jhotwara	Residential	Little	Little	JWAM II	,,	4	–	–	–	15	–	3	22	
3.	Bani Park	Residential	Little	Little	BPAM I	,,	8	–	–	–	10	–	5	23	
4.	Durgapura	Residential	Little	Little	DAM I	,,	4	–	–	–	–	–	–	4	
5.	Galta	Holy place	Moderate	Heavy	G I	,,	8	–	–	–	23	–	27	58	
6.	Galta	Holy place	Moderate	Heavy	G II	,,	3	–	–	–	–	–	–	3	
													Total:	152	Average 25.3

* As mentioned in table 2.

unimale bisexual group has only 19 individuals which lives in the residential area of the outskirts and the biggest group has 118 individuals and is found at Galta (Table 2).

On an average unimale groups are bigger than multimale and all male groups. The average number of individuals in unimale group is 54.4, whereas, multimale groups have an average of 40.0 individuals in each group, and all male has 25.3 individuals per group (Table 3).

The number of groups and individuals noted so far form a part of total population of langurs of Jaipur. There are still 5-7 or more groups to be studied.

Discussion

In the city of Jaipur 25 groups of langurs were located and observed in one year after 800 km. long road surveys (repeated survey), and during 550 contact hours. All three kinds of social groups, unimale, multimale, all male are found in this region. The majority of the groups were unimale bisexual. The groups were generally smaller in residential areas (Group JWUM I) as compared to groups at temples (Govindeoji and Galta; Table 2).

It has been noted during the present investigation that very few groups of langurs are found in the old city, as they prefer the outskirts of the city. One reason could be to avoid rhesus. The old city is dominated by rhesus (Mathur and Lobo; Wolfe and Mathur — in press) and the other reason could be their folivorous nature. There are very few trees in the old city (except in temples) as compared to the outskirts and Galta.

A comparison between the size of unimale groups indicate a relationship between group size and amount of provisioning (Table 4).

Table 4

Group size in relation to the provisioning of food

Sr. No.	Degree of provisioning	Group size (no. of individuals)
1.	Heavy	118, 102, 80, 111, 76
2.	Moderate	42, 42, 55, 54
3.	Little	31, 27, 36
4.	Very little or almost nil	19, 36, 20, 21

Wherever groups have heavy provisioning they have a bigger group size as compared to groups occupying areas where there is little provisioning or almost nil. At temples not only feeding is high but the animals also enjoy greater protection in comparison to residential areas — where monkeys are treated as pests and are chased away. Galta forms a specially favourable place for monkeys. It is a holy place, it is surrounded by low altitude hills. The area supports a variety of plant species on many of which langurs feed. Alongwith this there is heavy provisioning during certain days in a week. The present investigation is a preliminary report, and, further information is being collected for evaluating our data statistically.

Acknowledgements

We are very thankful to Dr. Mohnot, Department of Zoology, University of Jodhpur, Jodhpur, for his suggestion to start the population studies of Primates of Jaipur.

Financial assistance from UGC, New Delhi, is also gratefully acknowledged.

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2. OCCURRENCE OF THE BICOLOURED LEAF-NOSED BAT (*HIPPOSIDEROS FULVUS*) IN RAJASTHAN

On 29th November 1985, while observing Pythons in Keoladeo National Park, Bharatpur, I saw some microchiropterans moving inside one of the python holes. Later, the bat was collected and identified as bicoloured leaf-nosed bat (*Hipposideros fulvus*).

The upper part of the specimen had reddish brown hair with white base and the under part was more or less whitish. It had large pinna and tail which measured about 22 mm and 29 mm respectively.

Bicoloured leaf-nosed bat prefers porcupine

burrows for diurnal roosts (Roberts 1977). In this Park it co-exists with python and porcupine.

This is the first record of this species from Rajasthan as the distribution range of this common microchiropteran has been recorded as Central and Western India, Pakistan, Indonesia, Thailand, Taiwan (Brosset 1962 and Roberts 1977).

I thank Mr. Manoj Muni, BNHS for identifying the specimen and Dr. V. S. Vijayan, Project Scientist for encouragement.

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3. SIGHTING OF A RUSTY SPOTTED CAT (*FELIS RUBIGINOSA*)

The Rusty Spotted Cat was noticed fairly frequently in the forests of South Gujarat, especially of the Dangs and Valsad districts. I had myself sighted this cat in the Dangs and Vansda forests on a number of occasions in the past. However, in the last decade and a half, no sightings were reported and I feared that, with the inroads of human activities in these forest areas and the consequent destruction of it's habitat, this little cat may be on its way to extinction. It was therefore with a sense of happiness and some relief that I spotted one some time towards the 1st week of November 1986. I was driving along the main road going through the Vansda National Park when, on one of the turns of the ghat road known locally as "Vis-Gholiani Bari", I saw the small cat rush across in front of jeep and cross the road in full view in the headlights of my car. It was around 8-8.30 p.m. It stood for some time and then disappeared in the grass.

This species is rare throughout the country and I am not aware of there being any specimens in any Zoo. It may therefore be a good idea to trap two or three of these cats and try to breed them in captivity because otherwise we may stand to lose this species altogether.

I would also like to suggest that the Gujarat State Forest Department undertakes a quick field survey to determine the present status and distribution of this and other lesser cats in the state.

DIGVEERENDRASINH

DIGVIR NIWAS,
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DIST. VALSAD,
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January 20, 1987.

4. NOTE ON THE SIGHTING OF A CARACAL (*FELIS CARACAL*) AT THE SARISKA NATIONAL PARK

On 24th April between 6.15 and 6.30 a.m. I was travelling in a jeep between the Sariska National Park Gate and Kalighati within the park. The forest guard Shri Pratap Singh who was with me drew my attention to the caracal which was behind a few bushes and walking along the road and identified it as such. In a moment it passed a clearing before turning off away from the road when I could unmistakably see the animal's black ears with tufts on them.

This region has always had caracals, in fact there is a picture post card from Jaipur of about the turn of the century vintage which shows a cheetah (*Acinonyx jubatus*) and a caracal in captivity. The neighbouring erstwhile Jaipur state had a "cheetah khana" and the Maharajas hunted with both these animals. Incidentally, to the best of my knowledge the animal is identified in northern India by its Persian name only "Shia gosh", i.e. black ears.

I have been visiting this forest since 1972, but this is the first time I have come across a caracal there. However, according to a paper presented to the Cat Specialist Group at Kanha, April, 1984 entitled "Vanishing Cats of Rajasthan" by Vishnu Sharma and Kailash Sankhala, there are two reports of caracals in 1956, two in 1962, one in 1979 and one in 1982 in the Sariska region.

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June 4, 1986.

DIVYABHANUSINH

5. OCCURRENCE OF LARGE INDIAN CIVET (*VIVERRA ZIBETHA*) IN ORISSA

(*With a photograph*)

An adult Large Indian Civet (*Viverra zibetha*) was caught by villagers near screwpine (*Pandanus tectorius*) bushes of the village Banguari (Fulnakhara area in Cuttack District, Orissa) on January 12, 1986 and received at Nandankanan Biological Park in an injured condition (Photo. 1). The animal recovered after treatment. It is housed in an enclosure having a floor space of approximately seven square metres; height 2.80 metres and with two cave-like retiring dens. It is fed with minced meat, milk, boiled rice and fruits like banana and apple. The animal is sluggish during day and becomes active late in the evening when all the visitors had left. This appears to be the first record of occurrence of this Civet in Orissa.

Prater (1971) gives the distribution of Large Indian Civet as Nepal, Sikkim, Bhutan, Upper Bengal and Assam, extending eastwards into Burma, Southern China, Siam and the Malay Peninsula. The distribution of this

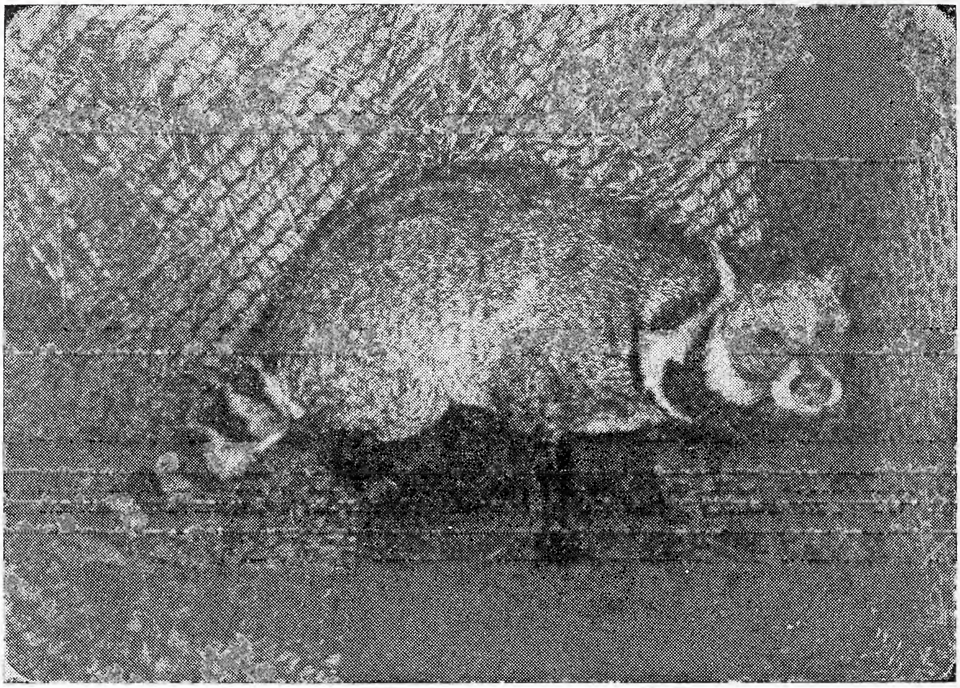

Photo 1. Large Indian Civet (*Viverra zibetha*) in Orissa.

species is given as Southern China, Nepal, Assam and eastward to the Malay Peninsula (Walker *et al.* 1964). The species has not been reported from Orissa (Das and Agrawal 1973, Behura and Guru 1969).

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6. A NOTE ON THE FOOD OF THE SMALL INDIAN CIVET (*VIVERRICULA INDICA*) AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

On 6th May 1986, by 0830 hrs. we found a dead Small Indian Civet possibly run over by a vehicle near Muniappan Eri at Point Calimere. We opened its stomach to examine the stomach contents and were surprised to see a large number of centipedes (not yet digested) and other food in the stomach. The stomach contents are as follows: 1. 16 Centipedes (intact; average length is 6-8 cm), 2. three broken portions of centipedes, 3. 7 crickets and broken parts of a few crickets, 4. a grain of paddy, 5. one *Prosopis juliflora* seed, 6. three legs of a frog and 7. a small quantity of fibrous portions of Palmyrah fruit (?). Though it has been recorded (Prater 1971) that the Small Indian Civet will feed on rats, squirrels, small birds, lizards, insects and their grubs, poultry, on anything which it can catch and kill, fruits, roots and other vegetable matter, it is interesting to note that it feeds on a large number of centipedes.

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7. UNUSUAL COLORATION OF NILGAI (*BOSELAPHUS TRAGOCAMELUS*)

On a recent visit to Sariska National Park in Rajasthan I came upon a young nilgai male which was uniformly a off-white colour and appeared a dirty white and distinct from the normal coloured nilgai which it was accompanying. It was not an albino as the eye coloration was normal.

In the same trip I also saw in the same locality around Kalighati a normal coloured nilgai with a streak of white coloration extending from the forehead to the nostrils and with a literal marking extending from eye to eye. This colour patch look was thus a T shape configuration. The bare skin around the nostrils was also cream coloured.

During my more than 40 years of observation of nilgai I have never come across coloration of this kind.

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PARYAVARAN BHAWAN,
C. G. O. COMPLEX,
LODHI ESTATE, NEW DELHI,
May 24, 1986.

M. K. RANJITSINH

8. OCCURRENCE OF THE BARHEADED GOOSE (*ANSER INDICUS*) IN SOUTH INDIA

According to S. Dillon Ripley's SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, the barheaded goose, a winter visitor to peninsular India, comes mainly to northern India, and south to Chilka Lake in Orissa, and is rare in Gujarat and Deccan but fairly regular in Karnataka in small numbers.

It certainly comes much farther south, to the purplieus of Tiruchi (where it has been shot), and I have seen it at Point Calimere which has a latitude of 10° 15′ to 10° 35′ N, as the BNHS team here must also have. In old ornithological literature, a still more southern sighting is reported: in THE BIRDS OF SOUTHERN INDIA by H. R. Baker and C. M. Inglis, it is said, with regard to this bird, "Mr. Hatchell records it from near Nellore and Cuddapah, and Geese [*sic*], which are probably this species, are reported to frequent the seacoast as far south as Pamban Island." Pamban Island is well above 9° N latitude.

In recent years, I have seen this goose in flocks of about 40 to 50 at two waterspreads south of Tirunelveli town, to both of which I went to observe the small flocks of the greater flamingo (*Phoenicopterus roseus*) which sojourn in them. On 27 January 1983 I visited Karungulam tank (besides Karungulam village and right beside the main road to Tiruchendur, some 15 km from Palayamkottai) and saw, besides the flamingos, a flock of about 40 barheaded geese which flew away at my approach. Inquiry of the local villagers elicited the information that they were regular visitors to this tank about January. The latitude of Karungulam is about 8° 32′ N. On 11 January this year (1985) I went to Koonthakulam, some 30 km south-east of Palyamkottai, and on the way saw a regular formation of about 50 white storks (*Ciconia ciconia,* and no doubt *ciconia* again) feeding busily in the grassy scrub besides the road. At Koonthakulam village, there is a mixed heronry of grey pelicans, painted storks, egrets and little cormorants nesting in the trees around, and flamingos haunt the tank right next the village. After a while, the flamingos flew off in a southeasterly direction, and following them I came upon a sizeable waterspread about 1 km away, at which they settled. A number of painted storks and 3 black ibises were on the slushy banks of the water, and a flock of barheaded geese (about 50) on the water. Villagers arriving to fill their water-pots made the birds take wing, and I had a good look at the geese as they flew overhead, and also pointed out to my companions that they were barheaded geese. The latitude of Koonthakulam is 8° 28′ N.

The interesting aspect of these sightings is that there does not seem to be any record of of the barheaded goose having been sighted in Sri Lanka, though there is a single record of the greylag. In recent years, migratory birds visiting south India have shifted their haunts considerably, and it could be that it is only comparatively recently that barheaded geese have taken to coming so far south. I do not know if they go to waters still farther south, as in Kanyakumari district.

M. KRISHNAN

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TAMIL NADU,
August 9, 1985.

9. THE OSPREY (*PANDION HALIAETUS HALIAETUS*) PREYING ON A GULL

I was very interested to read Mr. D. N. Goenka's letter dated 31.10.83 which you published in the Miscellaneous Notes of Vol. 82 No. 1 as it brought to mind the memory of an incident I observed in the Periyar Wildlife Sanctuary, as it then was, a good many years ago.

I quote from my notes at that time: 16.8.69. Periyar Lake. Seen harrying a common sandpiper and causing feathers to fly.

I can remember that the incident occurred near to Mullakudi. The osprey 'stooped' two or three times at the sandpiper which was flying along the shore-line. I do not know whether the attack was successful or not as the sandpiper, which was flying strongly, disappeared around a corner out of sight but I am sure I would have noted that the osprey went in pursuit of it had it done so.

As a matter of interest 16th August is a very early record for the arrival of the common sandpiper at Periyar, and that date is the earlier I recorded for the arrival of the osprey also.

M.C.A. JACKSON

FERNDALE, KILPEDDER,
GREYSTONES, CO. WICKLOW,
REPUBILC OF IRELAND,
October 30, 1985.

10. OCCURRENCE OF GREYHEADED LAPWING, *VANELLUS CINEREUS* (BLYTH) IN BANGALORE

On 18 April 1984 while observing birds in a paddy field at Kodigehalli, a village close to the Hebbal campus of the University of Agricultural Sciences, I sighted a Greyheaded Lapwing, *Vanellus cinereus* (Blyth). The bird which flew past me, settled close to a Redwattled Lapwing (*V. indicus*) in an inundated plot freshly transplanted with paddy seedlings. The bird was observed for 36 minutes with a pair of 8 × 30 field glasses.

The field characters of this bird agreed with the adult plumage of the species as given by Ali and Ripley (1969: 211). Besides, it was observed that the white in the secondaries of both wings was contiguous with the white of the rump and formed a wide 'V' pattern in flight. Before landing and take off, the bird spread its white tail out, exposing the conspicuous black subterminal band that narrowed out towards either side of the tail. The bird uttered a single plaintive *quee-ikt*, quite audible at a distance of about 10 m, whenever it took to the wings. While foraging at the edge of an inundated plot, covered with paddy stubbles and nut-grass (*Cyperus* sp.), the bird walked slowly stopping after every 2-3 steps and bent steeply to pick up some food item. When my approaches, to have a closer look, became frequent, the bird flew away with flight typical of lapwings. The bird was not seen again.

According to Ali and Ripley (1969), the breeding area of Greyheaded Lapwing spans over Mongolia, China (south to Yangtse valley), Manchuria, Korea and Japan. It winters in Southern China, India, North-East of Bihar,

Bangladesh, Burma, Malaya and the Indochinese region. Within Indian limits, it winters in small flocks in West Bengal, Assam, Manipur and N. Bihar. The bird is also reported from the Kathmandu valley of Nepal; and is recorded as a straggler in Kashmir, Dehra Dun, Bharatpur (Grubh 1968) and Andaman Islands. The present sighting is the first record of the species in Peninsular India.

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September 11, 1985.

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11. ADDITION TO THE BIRDS OF POINT CALIMERE, S. INDIA

In the checklist appended at the end of the paper on the Avifauna of Point Calimere (Sugathan (*JBNHS* 79: 567), *Muscicapa parva* is listed as occurring in Point Calimere. Recently while going through the collection of birds in BNHS I came across a specimen of *Muscicapa subrubra* (BNHS No. 23279 ♂) collected from Point Calimere on 9/10/1969. The specimen was identified as *M. parva subrubra* but presently *subrubra* is no longer considered as a race of *parva* and is given the status of a full species by Ripley (A SYNOPSIS OF BIRDS OF INDIA AND PAKISTAN 2nd ed. 1981). This would make *subrubra* an addition to the checklist.

In Overa Wildlife Sanctuary, in Kashmir, this year in May, I had the opportunity to examine both *M. parva* and *M. subrubra* in hand, as they were caught in the mist-net on the same day. The latter is common breeder in that locality. Also from the field observations I am quite convinced that they are different species.

NITIN JAMDAR

3 ROCKY HILL,
MALABAR HILL,
BOMBAY 400 006,
July 12, 1985.

12. FURTHER ADDITIONS TO THE AVIFAUNA OF POINT CALIMERE

Ruddy Shelduck (*Tadorna ferruginea*)

A group of 15 to 20 large ducks seen flying westwards over saltpans near Ramarpadam in the afternoon of 9th November 1983. The birds were typically 'Shelduck' in shape, the neck being proportionately too short for *Anser*.

The birds were seen against the sun thus colours were difficult to determine, however the forewing was clearly white/pale grey. The HANDBOOK records the species are 'rare or absent in the South' of the Peninsula but 'occasional' in Sri Lanka.

Wigeon (*Anas penelope*)

This species was inadvertently omitted from the first checklist (Sugathan 1983). Small numbers of wigeon are occasionally seen among the larger flocks of Pintail (*Anas acuta*) and Garganey (*Anas querquedula*). The largest number recorded is at least 200 on 31 January 1984 in association with *c.* 4,000 Pintail and 500 Garganey following heavy rain. The HANDBOOK records it as 'less common in the Peninsula' and 'sparse and irregular' in Sri Lanka.

Slenderbilled Gull (*Larus genei*)

One adult specimen of this gull was obtained on (17th Nov. 1969) while trapping waders for ringing. Published records of this species make no mention of the occurrence of the species beyond Bombay on the south (HANDBOOK vol. 3, pp. 35). The above specimen extends its range to Point Calimere in the south. The bird was ringed and released.

House Swift (*Apus affinis*)

A flock of 50-60 were seen over Kodikkarai harbour at mid-day on 7 November 1983. This species was seen in varying numbers (upto 150) throughout the Point Calimere area during the next fortnight.

Red-backed Shrike (*Lanius schach*)

Small numbers seen in November 1983.

Tree Pipit (*Anthus trivialis*)

Several tree Pipits were seen during November 1983 in an area of open grassland with scattered *Casuarina* trees. The back of these birds was reddish-brown, rather than the olive-brown of the Indian Pipit (*A. hodgsoni*), and heavily streaked with dark brown.

Indian Drongo-Cuckoo (*Surniculus lugubris*)

During October 1982 one of these birds was seen perched on an electric line in the Point Calimere Sanctuary. There after few more sightings were recorded from various parts of the sanctuary.

Dusky Horned Owl (*Bubo coromandus*)

On 16th October 1983, a specimen of *Bubo coromandus* was obtained from some village boys near Point Calimere sanctuary. The bird was very weak and died after a few hours. It was added to the skin collection of the Bombay Natural History Society.

Great Whitebellied Heron (*Ardea insignis*)

While driving along the Eastern side of the sanctuary Dr. Salim Ali identified one bird among a mixed flock of Egrets and Grey Herons at a drying water hole as *Ardea insignis.* During 1983 December again it was recorded along the edge of one of the artificial waterholes in the sanctuary. Perhaps this will be the first record of this species from South India (see Ali & Ripley HANDBOOK Vol. 1, pp. 53).

AVIFAUNA PROJECT,
POINT CALIMERE,
KODIKKARAI-614 807,
TAMIL NADU,
July 16, 1985.

R. SUGATHAN
DAVID S. MELVILLE
S. ALAGAR RAJAN

13. THE WHITEWINGED BLACK TERN, *CHLIDONIAS LEUCOPTERUS* (TEMMINCK) IN SAURASHTRA, GUJARAT

On May 14, 1985 I visited Lakhota, a lake in the middle of Jamnagar city, on the northern coast of Saurashtra. Flying about over the water was a loose group of 8-10 Whiskered Terns, *Chlidonians hybridus indicus* (Stephens). Some of the birds had already acquired their summer plumage while others were in an intermediate stage of moult. One bird in the group was with a black head, neck, back and belly, the underwing coverts also black and contrasting sharply against the silvery white wings, and a short slightly forked tail which was white in colour. The bird was unmistakably a Whitewinged Black Tern, *Chlidonias leucopterus* (Temminck) in full summer plumage. Its style of feeding was similar to that of the Whiskered Tern and the bird occasionally flew down to pick up something from the waters surface. After a few minutes of flying about in the area, the bird moved on to the other end of the reservoir beyond a bund and out of sight.

When the lake was visited six days later with Mr. Rishad Pravez the bird was seen again flying around in the same area.

Ali and Ripley (1983, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Compact Edition) state that this tern is a rare visitor to Assam, East Pakistan (now Bangladesh), West Bengal and Ceylon. There is one report of the bird from Raipur, Madhya Pradesh (D'Abreu, *JBNHS 38*: 112). This tern has been recorded thrice on the west coast of India, twice in Jasdan, Saurashtra by Shivrajkumar (*JBNHS 53*: 130) in June 1949 and May 1955 and once in Bombay by Abdulali (*JBNHS 49*: 310) at the end of March 1950. Roberts (*JBNHS 75*: 216) reported three birds north of Karachi in May 1977.

Ali and Ripley (l.c.) point out that this bird is possibly less "vagrant" than is recorded, as they are indistinguishable from the Whiskered Terns in their winter plumage. This seems to be well indicated by the fact that all the sightings of the bird have been made after late March when the tern starts moulting to its summer plumage.

I am grateful to my guide Prof. R. M. Naik for having read through the manuscript.

TAEJ MUNDKUR

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14. OCCURRENCE OF PIED CRESTED CUCKOO (*CLAMATOR JACOBINUS*) IN SURU VALLEY, LADAKH

In the last week of June 1985, I made a brief visit to Suru Valley, Ladakh, to study the Mountain chifchaff (*Phylloscopus sindianus*). On 28th June I was in the village Kanoor (alt. approx. 2590 m), 16 km from Kargil and situated on the left bank of Suru river.

Here the valley spreads out, and is cultivated with barley fields with willow groves on the borders.

In the afternoon while I was examining a nest of *P. sindianus,* a large black & white bird flew overhead, calling. It landed on a branch of a willow tree, 20 feet from the ground. It perched in strong sunlight for 6-7 minutes, before making a dash to the next willow tree. To my amazement I found it to be a Pied-crested cuckoo (*Clamator jacobinus*) which could be mistaken here for a Pied magpie (*Pica pica*), at a casual glance. But closer scrutiny settled the doubt. As I am very familiar with this cuckoo in the plains, I did not hesitate to put it down as Pied-crested cuckoo (*C. jacobinus*). Its distinctive calls further aided the identification. This bird was later heard calling in the next willow grove. It was giving the same plaintive calls as it gives in plains, when it arrives in the monsoons.

The distribution of this cuckoo is given by Ali & Ripley (HANDBOOK Vol. 3) as "West Pakistan & Northern India, Sind, Punjab, Gilgit, Kashmir, U.P. ....". "Vagrants have been recorded from Tingri (4270 m) in Tibet and below Rohtang pass in Himachal Pradesh at 3800 m". The distribution and migration of this cuckoo is not clear and is very ambiguous. Its worth noting that the forest department, in recent years has undertaken large scale afforestation programmes, which has drastically changed the ecology of the valley. Occurrence of this species in the area where it has never been recorded before, is possibly linked with the above factor.

NITIN JAMDAR

3, ROCKY HILL,
MALABAR HILL, BOMBAY 400 006,
July 10, 1985.

15. SIGHTING OF BLACKNAPED ORIOLE

While on a visit to Karnala Bird Sanctuary on 25th November 1985 I and Miss Nita Mehta spotted a group of Blacknaped Orioles (*Oriolus chinensis*) flying around and calling in the teak plantation and other trees growing near a dammed stream. The sighting of Blacknaped Oriole reported around Bombay in 1944 and 1946 in HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN by Salim Ali and S. Dillon Ripley and "Checklist of the Birds of Maharashtra" by Humayun Abdulali were reported as RS (Stray Record). However, a few specific observations made during the sighting are as under:

1) All the birds observed, four in all, had olive green/grey back with black on wings and tail. Incidentally, this plumage is that of female and immature *Oriolus chinensis diffusus* reported for this region.
2) The birds had narrower line running through their eyes and round the nape than reported for *Oriolus chinensis diffusus* and more like that of Slenderbilled Blacknaped Oriole *Oriolus chinensis tenuirostris.* Further, none of the Orioles observed had any streaks on plumage.

However, the Orioles considering the distribution could only be *Oriolus chinensis diffusus* and it would be of interest if observations are made on immature plumage of the blacknaped oriole and forwarded to BNHS.

D. P. BANERJEE

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M. G. ROAD,
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16. NEST OF THE PIED MYNA *STURNUS CONTRA* LINNAEUS

The true home of the Pied Myna is continental India, Assam and Manipur, whence it ranges into Burma, the Indochinese and the Malaysian subregions.

A favourite cage bird, the Pied Myna is usually available in Bombay's bird market, consignments being obtained from north India. Escapes of these cage birds have now established themselves in and around Bombay. In 1951 its breeding was recorded in the Bombay area of Dharavi by Humayun Abdulali (*J. Bombay nat. Hist. Soc. 51*: 736-7). Since then a number of nests have been recorded all over Greater Bombay, and the bird appears to be extending its range northwards.

Normally the Pied Myna builds a globular nest composed of dry grass, hay and rags, placed in forks of tree trunks or branches. The nests are domeshaped over the egg chamber with a side entrance.

I recently, however, came across a nest in the Aarey Milk Colony at Goregaon, Bombay placed in an up-turned oblong glass shade of a street lamp. The bird entered and left the nest through the broken side of the lamp. The Pied Myna appears to be versatile, adapting itself to conditions obtaining in its new home.

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VASANT R. NAIK

17. KALIVELI TANK AND YEDAYANTHITTU ESTUARY — A LITTLE KNOWN WETLAND HABITAT IN TAMIL NADU

Situated to the north of Pondicherry is the Kaliveli tank and its estuary. It runs along the coast towards Marakkanam and beyond where it enters the sea. The tank is an integral part of what is known as the kaliveli watershed. The watershed comprises about 400 sq. km. and is a selfcontained mini ecosystem. The area can be roughly divided into three habitats. One is the plateau, which is mainly dryland area. It has a system of tanks, ponds and ravines through which the run-off rainwater is being fed into the tank. The plateau has a maximum elevation of 55 m. Second is the tank proper and third the estuary. The tank is a non tidal seasonal fresh water habitat and comprises about 850 ha. The water level fluctuates according to precipitation. The highest water level observed was about 2.1 m after a period of heavy rainfall. Mean water level is about 0.91 m. The tank empties into the sea through a narrow channel which connects the tank with the estuary. The estuary is a tidal salt water habitat with a saltpan complex. The area is about 567 ha.

Historic indications are that the area surrounding the tank was at one time heavily forested, even as recent as 25 years ago. Recently, in a village close to the tank, a stone slab was discovered with inscriptions. One of the inscriptions deciphered tells how a king was hunting elephants in the surrounding forest. Archeologists dated the stone as from

the 18th century. This is indicative of the wildlife that once must have existed in the Kaliveli area. Old people in the villages sometimes tell you that many years ago they were employed to help clear large tracts of forest. At two locations one can still find the remnants of the ancient forest. A few acres is all that is left. It is therefore assumed that the tank must have been once covered with water the year round. Now, in years of scant rainfall, the tank is dry for a few months. By the outlet to the sea there are low sand dunes. A few straggly mangroves are all that remain of what once must have been a large mangrove forest.

Indications are that the tank plays an important role in the migratory habits of many bird species as it lies on the same migratory trail as Point Calimere. During the migratory season there are usually about 40,000 birds of different species present in the tank and about 20,000 in the estuary. Although the number of species present during this period remains roughly the same, the numbers present within the species do fluctuate. It is assumed that there is a fair amount of movement of various species between the tank and the tanks and ponds on the plateau. It is also assumed that there is a continuous movement of various species between Point Calimere, Vedanthangal and the Kaliveli tank. On the plateau one often sees great flocks of birds passing over, generally wetland birds, going either north-south or south-north. In March 1984 a survey took place for 5 days. More than 120 species were observed (see appendix). The following points were of particular interest:

1. There was a large concentration of dabbling ducks, numbering at least 10,000 birds. Four species were recorded all in large numbers: Garganey, Wigeon, Shoveller and Pintail.
2. A flock of 36 Ruddy Shelduck was seen feeding in the estuary. This species is rare or absent in the south. (Ali, S. & Ripley, S. D. 1981)
3. Both Greater and Lesser Flamingos were recorded. The Lesser Flamingos status is uncertain. (Ali, S. & Ripley, S. D. 1981) 5 were observed in the estuary.
   The pattern observed for the Greater Flamingo is a gradual increase in numbers. Usually the first birds arrive during the end of November and the beginning of December. A flock of about 300 is normal for this time. It increases to about 3000 to 4000 birds during March-April after which the birds disperse for the return journey to their breeding grounds. On May 15th 1985, 5 birds were still found in the tank which is unusual.
4. There is a major tern roost in the estuary. Observed at one time 10,000 Whiskered Tern, 400+ Gullbilled Tern and very few Caspian, Large Crested and Little Tern.
5. One morning a flock of 35 Spotbilled Pelicans was observed feeding in the middle of the estuary. That same evening a flock of 41 was observed sitting on the bunds of the saltpan complex.
   In June 1984 a flock of 54 birds was seen in the tank although there was little or no water. In November 1984 about 70 were observed in the tank. In January 1985 a solitary bird was seen and in February 1985 a flock of about a hundred were observed in the tank. Spotbilled Pelican is thought to be an endangered species by some authorities. (Neelakantan, K. K. 1980).
6. One pair of White-Bellied Sea Eagles was observed attending a large eyrie in the estuary. The eyrie was very large and presumed to be at least several years old.

For some species a presence of a few thousand is not uncommon. Others are represented only by small numbers. Of the birds

observed during March 1984, 43 were migrants, 6 species of which the status is unknown and 14 species which are considered rare in the south. (Ali, S. & Ripley, S. D. 1981, 1969, 1969).

The coast is visited by many birds during the migratory season, many of whom roost in the tank or estuary during the night. The early morning sees many such birds flying and feeding along the coast. At certain places along the coast turtles (pres. Ridley) come to the beach to lay their eggs. The only evidence of this we have so far are turtle eggs offered for sale by the local population. Regarding the marine life in the tank and estuary little is known to date. The local population catch fresh water prawns, mainly for their own consumption. Once a Little Tern was observed catching a small fish. The French Institute in Pondicherry has some information on the flora of the tank and its surrounding area.

The health and potential improvement of this unique eco-system depends to a large extend on the health of the watershed. The tank is one of the last unpolluted estuaries on the east coast of India although it is suspected that because of the use of agricultural pesticides on the plateau the tank is slowly being polluted. Possible threats to this eco-system is the planned industrialization of an enclave of Pondicherry State in Tamil Nadu. Already a caustic soda factory is in operation releasing its affluent into a ravine. The environmental damage this causes has as yet to be ascertained. This area is one of few such eco-systems on the sub-continent and its destruction would be a serious loss. It is therefore recommended that the entire Kaliveli watershed area should be declared as a bird sanctuary and effectively protected. The Centenary seminar of the B.N.H.S. requested that high priority should be given to the identification and listing of all significant wetland habitats and the setting up of wetland nature reserves. (Resolution 4, no. 7). It is my opinion that the Kaliveli watershed area is such a habitat and is in need of full protection.

ACKNOWLEDGEMENTS

We are grateful to Richard Grimmet and Craig Hobson who took time from their busy itinerary to survey the birdlife in the Kaliveli tank. The birdlist is mostly their work as well as some of the information. S. A. Hussain for sending them and for all the help and encouragement he has given and still gives.

PIETER

CENTRE FIELD,
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September 24, 1985.

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APPENDIX

List of bird species observed at Kaliveli tank and Yedayanthittu estuary. November 1983 till July 1985

1. Spottedbilled Pelican, *Pelecanus philippensis.*
2. Grey Heron, *Ardea cinerea.*
3. Paddybird, *Ardeola grayii.*
4. Large Egret, *Ardea alba.*
5. Median Egret, *Egretta intermedia.*
6. Little Egret, *Egretta garzetta.*
7. Indian Reef Heron, *Egretta gularis.*
8. Night Heron, *Nycticorax nycticorax.*
9. Painted Stork, *Mycteria leucocephala.*
10. Openbill Stork, *Anastomus oscitans.*
11. Whitenecked Stork, *Ciconia episcopus.*
12. White Stork, *Ciconia ciconia.*
13. Blacknecked Stork, *Ephippiorhynchos asiaticus.*
14. White Ibis, *Threskiornis aethiopica.*
15. Glossy Ibis, *Plegadis falcinellus.*
16. Spoonbill, *Platalea leucorodia.*
17. Flamingo, *Phoenicopterus roseus.*
18. Lesser Flamingo, *Phoeniconaias minor.*
19. Barheaded Goose, *Anser indicus.*
20. Ruddy Shelduck, *Tadorna ferruginea.*
21. Pintail, *Anas acuta.*
22. Wigeon, *Anas penelope.*
23. Garganey, *Anas querquedula.*
24. Shoveller, *Anas clypeata.*
25. Pariah Kite, *Milvus migrans.*
26. Brahminy Kite, *Haliastur indus.*
27. Shikra, *Accipiter badius.*
28. Booted Hawk-Eagle, *Hieraaetus pennatus.*
29. Whitebellied Sea-Eagle, *Haliaeetus leucogaster.*
30. White Scavenger Vulture, *Neophron percnopterus.*
31. Pale Harrier, *Circus macrourus.*
32. Montagu's Harrier *Circus pygargus.*
33. Pied Harrier, *Circus melanoleucos.*
34. Marsh Harrier, *Circus aeruginosus.*
35. Osprey, *Pandion haliaetus.*
36. Peregrine Falcon, *Falco peregrinus.*
37. Kestrel, *Falco tinnunculus.*
38. Grey Partridge, *Francolinus pondicerianus.*
39. Blackwinged Stilt, *Himantopus himantopus.*
40. Avocet, *Recurvirostra avosetta.*
41. Stone Curlew, *Burhinus oedicnemus.*
42. Indian Courser, *Cursorius coromandelicus.*
43. Redwattled Lapwing, *Vanellus indicus.*
44. Grey Plover, *Pluvialis squatarola.*
45. Eastern Golden Plover, *Pluvialis dominica.*
46. Little Ringed Plover, *Charadrius dubius.*
47. Kentish Plover, *Charadrius alexandrinus.*
48. Lesser Sand Plover, *Charadrius mongolus.*
49. Whimbrel, *Numenius phaeopus.*
50. Curlew, *Numenius arquata.*
51. Blacktailed Godwit, *Limosa limosa.*
52. Spotted Redshank, *Tringa erythropus.*
53. Redshank, *Tringa totanus.*
54. Marsh Sandpiper, *Tringa stagnatilis.*
55. Greenshank, *Tringa nebularia.*
56. Green Sandpiper, *Tringa ochropus.*
57. Wood Sandpiper, *Tringa glareola.*
58. Terek Sandpiper, *Tringa terek.*
59. Common Sandpiper, *Tringa hypoleucos.*
60. Turnstone, *Arenaria interpres.*
61. Pintail Snipe, *Gallinago stenura.*
62. Fantail Snipe, *Gallinago gallinago.*
63. Little Stint, *Calidris minuta.*
64. Temminck's Stint, *Calidris temminckii.*
65. Longtoed Stint, *Calidris subminuta.*
66. Dunlin, *Calidris alpina.*
67. Curlew Sandpiper, *Calidris testacea.*
68. Ruff, *Philomachus pugnax.*
69. Herring Gull, *Larus argentatus.*
70. Great Blackheaded Gull, *Larus ichthyaetus*
71. Brownheaded Gull, *Larus brunnicephalus.*
72. Blackheaded Gull, *Larus ridibundus.*
73. Whiskered Tern, *Chlidonias hybrida.*
74. Whitewinged Black Tern, *Chlidonias leucopterus.*
75. Gullbilled Tern, *Gelochelidon nilotica.*
76. Caspian Tern, *Hydroprogne caspia.*
77. Common Tern, *Sterna hirundo.*
78. Little Tern, *Sterna albifrons.*
79. Large Crested Tern, *Sterna bergii.*
80. Blue Rock Pigeon, *Columba livia.*
81. Spotted Dove, *Streptopelia chinensis.*
82. Roseringed Parakeet, *Psittacula krameri.*
83. Common Hawk-Cuckoo, *Cuculus varius.*
84. Spotted Owlet, *Athene brama.*
85. Palm Swift, *Cypsiurus parvus.*
86. Pied Kingfisher, *Ceryle rudis.*

87. Common Kingfisher, *Alcedo atthis.*
88. Whitebreasted Kingfisher, *Halcyon smyrnensis.*
89. Bluetailed Bee-Eater, *Merops philippinus.*
90. Green Bee-Eater, *Merops orientalis.*
91. Indian Roller, *Coracias benghalensis.*
92. Crimsonbreasted Barbet, *Megalaima haemacephala.*
93. Hoopoe, *Upupa epops.*
94. Goldenbacked Woodpecker, *Dinopium benghalense.*
95. Redwinged Bush Lark, *Mirafra erythroptera.*
96. Ashycrowned Finch-Lark, *Eremopterix grisea.*
97. Rufoustailed Finch-Lark, *Ammomanes phoenicurus.*
98. Eastern Skylark, *Alauda gulgula.*
99. Collared Sand Martin, *Riparia riparia.*
100. Swallow, *Hirundo rustica.*
101. Black Drongo, *Dicrurus adsimilis.*
102. Common Myna, *Acridotheres tristis.*
103. Brahminy Myna, *Sturnus pagodarum.*
104. Indian Tree Pie, *Dendrocitta vagabunda.*
105. House Crow, *Corvus splendens.*
106. Jungle Crow, *Corvus macrorhynchos.*
107. Common Wood Shrike, *Tephrodornis pondicerianus.*
108. Common Iora, *Aegithina tiphia.*
109. Redvented Bulbul, *Pycnonotus cafer.*
110. Whiteheaded Babbler, *Turdoides affinis.*
111. Tailor Bird, *Orthotomus sutorius.*
112. Green Warbler, *Phylloscopus nitidus.*
113. Magpie Robin, *Copsychus saularis.*
114. Indian Robin, *Saxicoloides fulicata.*
115. Paddyfield Pipit, *Anthus novaeseelandiae.*
116. Richard's Pipit, *Anthus n. richardi.*
117. Yellow Wagtail, *Motacilla flava.*
118. Pied Wagtail, *Motacilla maderaspatensis.*
119. Purplerumped Sunbird, *Nectarinia zeylonica.*
120. Loten's Sunbird, *Nectarinia lotenia.*
121. Purple Sunbird, *Nectarinia asiatica.*
122. House Sparrow, *Passer domesticus.*
123. Yellowthroated Sparrow, *Petronia xanthocollis.*
124. Baya Weaver Bird, *Ploceus philippinus.*
125. Whitethroated Munia, *Lonchura malabarica.*

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18. THE REDFRONTED BABBLER *STACHYRIS RUFIFRONS* AND REDHEADED BABBLER *S. RUFICEPS* IN NORTHERN THAILAND

Introduction

In south-east Asia there is a pair of very similar species of rufouscapped babblers of the genus *Stachyris* which nevertheless have diagnostic characters (Harrison 1985). The more northerly species, the Redheaded Babbler *S. ruficeps*, has a uniform chestnut cap extending back to the nape and merging with the mantle. The pale throat merges into the paler parts of the ochraceous-buff bordered upper breast. The more southerly Redfronted Babbler *S. rufifrons* has a chestnut cap extending back no further than the hind-crown and showing indistinct dark streaking along the feather shafts. The pale throat is separated from the rest of the underside by a more distinct zone of slightly rufous buff on the upper breast.

S. ruficeps occurs from the Yangtze Valley southwards in China to Yunnan and the northern parts of Vietnam and Laos. Westwards it occurs through the Himalayas to Sikkim and into north-eastern and north-western Burma. It has an isolate population in southern Vietnam.

S. rufifrons occurs in the Himalayas from Nepal eastwards into Assam, north-eastern and southern Burma, northern Laos and Vietnam, and into Malaya, Sumatra and Burma. It has an isolate population in southern Laos.

The two species appear to overlap in range in areas from northern Laos to Sikkim. There seems to be an altitudinal difference in breeding range, following the general rule with the higher latitude species *S. ruficeps* breeding at higher altitudes where they overlap. Baker (1922) writing of their range in India and Burma, stated that *ruficeps* bred from upwards

of 760-915 m, and *rufifrons* up to 610 m. He stated that *rufifrons* may breed ".. occasionally higher than this and nests of both .. may be found in the same jungle." This would appear to infer local sympatry when breeding, but since Baker's work has shown some evidence of poor species differentiation (Harrison and Parker 1966) and apparent deception (Harrison 1966, Harrison and Parker 1967) in other instances, there may be some reservation about accepting the statement without additional confirmation.

S. rufifrons IN NORTHERN THAILAND

Deignan encountered a problem concerning the distribution of these species in northern Thailand and, in attempting to solve it, altered some of his views between an early paper (1939), his list of birds of northern Thailand (1945), and his Thailand checklist (1963) and list of Timaliinae in Peters's Checklist (1964) without fully justifying them.

He collected a specimen at 1340 m on Doi Ang Ka, a high peak of the Thanon Thong Chai range 56 km WSW of Chiang Mai, and saw other pairs in thick vegetation. He assigned the specimen (now in the Field Museum, Chicago) to the nominate subspecies *S. rufifrons rufifrons* Hume 1873 which occurs from the Burmese Shan States into western Thailand.

Meyer de Schauensee had collected a specimen at 1950 m on Doi Hom Pok, a peak of the Daen Lao range on the Thailand/Burma frontier about 77 km WNW of Chiang Rai. Gyldenstolpe had specimens from Pha Kho, east of the Khun Tai range, and Doi Pha Sakaeng, both from the undergrowth of dense evengreen forest in valleys. These were typical specimens of *S. rufifrons* and Deignan (1945) assigned all three to the subspecies *S. r. insuspecta* Deignan 1939, the type of which was a specimen of the isolate form from the Bolovens Plateau of southern Laos. Later (1963, 1964) he transferred them to the subspecies *S. r. adjuncta* Deignan 1939, the type of which was from Phong Saby in northern Laos.

On Doi Chiang Dao, a 2182 m peak in the Thanon Thong Chai range 40 miles north by west of Chiang Mai, three birds were collected at 1166-1676 m, one by Meyer de Schauensee in grassland, the others by Deignan in tall bamboo forest. They resembled *S. rufifrons,* but were darker and greyer than any described subspecies. Deignan first assigned them to a new species *S. rodolphei* Deignan 1939, but in 1945 treated this as a subspecies of *S. rufifrons,* and in 1963 and 1964 reverted to species status for it.

There would therefore appear to be evidence from various scattered localities across the highlands of northern Thailand of specimens of *S. rufifrons,* assigned to various poorly-differentiated subspecies, with a distinctive and apparently isolate form on Doi Chiang Dao.

THE SECOND SPECIES ON DOI CHIANG DAO

On Doi Chinag Dao in 1931, on steep grass-covered slopes at *c.* 1829 m above the latitudinal range noted for *S. rufifrons rodolphei,* Deignan encountered a small party of *Stachyris* babblers and collected one specimen. He described it as "mutilated" and later as "fragments" and it was not preserved with his other specimens. He stated "It was identified in the flesh as a form of *Stachyris ruficeps* as understood by Stuart Baker (FAUNA OF BRITISH INDIA. Birds, Ed. 2, Vol. 1, 1922, p. 268), and my identification of the fragments was subsequently confirmed by Chasen at the Raffles Museum."

Baker, in the work cited, gives a key and descriptions of two subspecies *S. ruficeps* and two of *rufifrons*. There should have been no problems of identity involved. From his statement there would appear to be no reason to doubt that Deignan had identified the presence of a party of *S. ruficeps* at higher altitudes on Doi Chiang Dao, with the distinctive isolate of *S. rufifrons, S. r. rodolphei* at lower altitudes, reflecting the altitudinal preferences evident elsewhere.

Subsequent taxonomic changes

The apparent distribution of the two species with an isolate of *S. ruficeps* in northern Thailand, sympatric with a distinctive population of *S. rufifrons*, but apparently separated altitudinally, would appear to be a fairly simple one.

However, in his 1945 study of birds of northern Thailand Deignan, fourteen years after his examination of the specimen he had identified as *S. ruficeps* and not subsequently retained, stated "I have no doubt that the example belonged to the race later named *insuspecta*." He does not say why, nor why he assigned a specimen he had identified as *S. ruficeps* to a subspecies then considered to belong to *S. rufifrons*. In this work he had treated *rodolphei* as a subspecies of *S. rufifrons* and now had a problem of sympatry which he solved by assigning *insuspecta* as a whole to *S. ruficeps*, appearing to ignore the fact that all but one of the specimens involved were typical of *S. ruficeps*.

In his arrangement of the babblers in the Thailand checklist (1963) and Peters's checklist (1964) he changed his mind again, and apparently wished to return these birds to *rufifrons*. He transferred them to the subspecies *adjuncta* of the latter species. He makes no mention of the Doi Chiang Dao *ruficeps* specimen, nor of the locality, but may have been aware that he might have a problem of sympatric subspecies in his new arrangement, since he now treats *rodolphei* as a full species.

The problems raised in his mind by the Doi Chiang Dao birds would seem to be the only rational explanation for his division (1963, 1964) of the subspecies of *S. rufifrons* to form two species, using *ambigua* Harington 1915 as the second specific name. In doing so he retained *pallescens, obscura, poliogaster* and *sarawacensis* in *S. rufifrons*; and transferred *planicola, adjuncta* and *insuspecta* to his new *S. ambigua*. Dickinson (pers. comm.) has suggested that he may have been influenced to some extent by the relative proximity in northern Thailand of the specimens he had assigned to *S. r. rufifrons* and *S. r. adjuncta* (or *insuspecta*); but since, as Dickinson pointed out, the former is in the drainage of the Chao Phaya and the latter in that of the Mae Khong, they are not sympatric, a fact of which Deignan must have been aware.

At no time did Deignan state the characters which would justify the recognition of two species based on the subspecies normally assigned to *S. rufifrons*. From an examination of skins it seems possible that he was attempting to use the presence of absence of some yellowish tint in the plumage of the populations in order to separate them. He appears to have ignored a more striking pigmentation variation of this kind in the subspecies of *S. ruficeps*. There appears to be no justification for such a separation other than as an attempt to overcome a taxonomic problem which he had in any case solved for himself by elevating *rodolphei* to a full species.

Conclusions

Further material from the Doi Chiang Dao region would be useful. From a study of

specimens, and from the information given by Deignan on the specimens involved, it would appear that in northern Thailand *S. rufifrons* is present in various localities, showing some local variation, with a distinctive isolate on Doi Chiang Dao which has been treated at times as a separate species *S. rodolphei.* An isolated population of *S. ruficeps* may be present at higher altitudes on the same peak.

If Deignan's unsubstantiated second thoughts (1945) about the second isolate on Doi Chiang Dao were correct, then one would need to envisage a double invasion by *S. rufifrons* in this locality with *S. rodolphei* as a species arising from the earlier invasion.

In either instance there would appear to be no justification for a subdivision of the subspecies of *S. rufifrons* to form two species as suggested by Deignan (1964). It has not been generally accepted. Ali and Ripley (1971) treat *ambigua* as a subspecies of *rufifrons.*

Summary

The Redfronted Babbler *Stachyris rufifrons* is known to occur in scattered localities in northern Thailand. A distinctive form *rodolphei,* originally described as a new species, occurs on Doi Chieng Dao. A specimen from higher altitudes on that mountain was identified as the Redheaded Babbler *S. ruficeps.* This Deignan assigned, with specimens of *S. rufifrons,* to a subspecies which he then moved from *ruficeps* to *rufifrons.* He attempted to solve the ensuing taxonomic confusion by dividing subspecies of *S. rufifrons* to create a new species *S. ambigua* without justifying or defining the latter, and using an earlier subspecific name. This action appears unnecessary.

Acknowledgements

I am grateful to E. C. Dickinson for his summary of Deignan's treatment of these species and for his comments; to Dr. D. Willard for information on specimens in the Field Museum of Natural History; and to the Naturhistoriska Riksmuseet of Stockholm for loan of specimens.

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19. THE INDIAN GREY TIT (*PARUS MAJOR*) ON AN ABANDONED HONEY COMB

In the compound of the Irrigation Department's guest house at Nandur-Madhameshwar (Nasik District), there are a number of honey combs on the branches of two large ficus trees at a height of over 50 feet. On 11th February 1985, while we were watching two spotted owlets on an adjacent tree, we noticed a Grey Tit (*Parus major*) perched on the top half of an abandoned honey comb. Perching at an angle of 135° to the ground, the tit kept probing into the hexagonal cells in the comb. Though we are unable to state with any degree of certainty that there were no insects present in the comb, we are reasonably certain that there were none. This is because the top half of the comb was white, and therefore totally devoid of honey, the bottom portion of the comb was brown and may have contained some honey residue, and therefore maybe some insects also. Secondly, during a previous trip to Nandur-Madhameshwar in July 1984, we had picked up a honey comb from the ground from practically the same spot. This honey comb was also empty both of honey and insects, and the fact that the entire comb was intact indicated that the comb had not been knocked down from the tree by any human agency for the sake of its honey.

Sálim Ali and S. Dillon Ripley, in the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN (Vol. 9, pp. 169) state that the food of the grey tit comprises of "insects, caterpillars, seeds, flower buds and berries". We are unable to find any other reference on the food of the Indian Grey Tit. Mr Humayun Abdulali, when consulted, was unable to recall the sighting of a grey tit on a honey comb.

We would therefore conclude that though there is a possibility that the grey tit may not have been feeding on the wax, the sighting of the tit on the honey comb itself should be recorded.

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HETA PANDIT

20. HOST PLANTS USED BY BAYA WEAVER BIRD (*PLOCEUS PHILIPPINUS* LINN.) FOR NESTING IN EASTERN RAJASTHAN

(Breeding period 1982)

A study has been done by me on plants preferred by *Ploceus philippinus* Linn. for nesting in two districts of Eastern Rajasthan *viz.* Alwar and Bharatpur. For this purpose I cycled some 280 km on the following roads: 1. 30 km on N.H. 11 from Bharatpur to Halena; 2. 110 km on S.H. 14 from Bharatpur to Alwar; 3. 60 km on S.H. 14 from Alwar to Behror; 4. 20 km on N.H. 8 from Behror to Neemrana; 5. 30 km on S.H. 13 from Sariska

TABLE 1

DICOT HOSTS FOR NESTING

Sl. No. of family	Name of family	S. No. of species	Name of Plant	No. of plants used for nesting	Special note
1.	Capparidaceae	1.	*Capparis decidua* (Forsk.) Edgew.	2	
		2.	*C. sepiaria* Linn.	4	
2.	Simaroubaceae	3.	*Balanites aegyptica* (Linn.) Delile	6	
3.	Celastraceae	4.	*Maytenus emarginata* (Willd.) Ding Hou.	6	
4.	Meliaceae	5.	*Azadirachta indica* A. Juss.	14	
		6.	*Melia azedarach* Linn.	3	
5.	Rhamnaceae	7.	*Zizyphus mauritiana* Lamk.	38	
6.	Leguminosae	8.	*Pongamia pinnata* (Linn.) Pierre	2	
		9.	*Dalbergia sissoo* Roxb.	18	
		10.	*Acacia nilotica* (Linn.) Del. subsp. *indica*	1246	
		11.	*A. n.* (Linn.) Del. subsp. *cupressiformis*	3	
		12.	*A. leucophloea* Willd.	71	
		13.	*A. jacquemonti* Benth.	8	
		14.	*A. tortilis*	2	
		15.	*A. senegal* (Linn.) willd.	9	
		16.	*A. catechu* Willd.	10	
		17.	*Prosopis cineraria* (Linn.) Druce	373	
		18.	*P. chilensis* (Molina)	2	
		19.	*Albizzia lebbek* (Linn.) Benth.	4	
		20.	*Tamarindus indicus* Linn.	2	
		21.	*Sesbania sesban* (Linn.) Merr.	2	
		22.	*Butea monosperma* (Lamk.) Taub.	5	
		23.	*Leucaena leucocephala* (Lamk.) De. wit.	1	
		24.	*Bauhinia racemosa* Linn.	1	
		25.	*Parkinsonia aculeata* Linn.	3	
7.	Myrtaceae	26.	*Eucalyptus tereticornis*	8	
8.	Tamaricaceae	27.	*Tamarix dioica* Roxb.	8	
9.	Moraceae	28.	*Ficus religiosa* Linn.	6	
		29.	*F. benghalensis* Linn.	1	
		30.	*Morus indica* Linn.	5	
10.	Moringaceae	31.	*Moringa oleifera* Lamk.	1	
11.	Combretaceae	32.	*Anogeissus pendula* Edgew.	3	
12.	Lythraceae	33.	*Lawsonia enermis* Linn.	5	Inside Alwar City
13.	Rubiaceae	34.	*Anthocephalus cadamba* Miq.	10	
14.	Salvadoraceae	35.	*Salvadora persica* Linn.	12	
15.	Asclepiadaceae	36.	*Calotropis procera* R. Br.	1	On a vertical bank of river
16.	Apocynaceae	37.	*Wrightia tinctoria* R. Br.	1	
17.	Boraginaceae	38.	*Cordia dichotoma* Forst.	4	
		39.	*C. gharaj* (Forsk.) Ehrenb.	1	On berm of old well

18.	Bignoniaceae	40.	*Tecomella undulata* (Sm.) Seem	4	
19.	Acanthaceae	41.	*Adhatoda vasica* Nees	1	On berm of old well
20.	Casuarinaceae	42.	*Casuarina equisetifolia* Forst.	1	
21.	Euphorbiaceae	43.	*Emblica officinalis* Gaertn.	2	
22.	Ulmaceae	44.	*Holoptelia integrifolia* Planch	8	
23.	Punicaceae	45.	*Punica granatum*	6	Inside Alwar City
Total	23 Families		35 Genera 45 Species	1923	

TABLE 2

MONOCOT HOSTS FOR NESTING

Sl. No. family	Name of family	S. No. of species	Name of Plant	No. of plants used for nesting	Special note
1.	Palmae	1.	*Phoenix sylvestris* Roxb.	24	
2.	Gramineae	2.	*Cynodon dactylon* Pers.	–	Hanging grass trail in old wells.
Total	2 Families		2 Genera 2 species	24+	

tiger project to Alwar and 6. 30 km on local roads.

To study the preferred nesting plants I concentrated my attention on 50 m wide strips of land on either side of the road. My observations are as follows: (see Tables 1 & 2).

It is clear from these tables that *Acacia nilotica* subsp. *indica* is the most preferred host tree in Eastern Rajasthan followed by *Prosopis cineraria, Acacia leucophloea, Zizyphus mauritiana* and *Phoenix sylvestris.* Similarly the Family Leguminosae is the most preferred family of all others.

It is very interesting that *Acacia nilotica* subsp. *cupressiformis* which is very near to *Acacia nilotica* subsp. *indica* is not preferred by baya for nesting. The only reason seems to be that the subsp. *cupressiformis* has upwardly directed branches while the baya prefers drooping branches for hanging its nest which are abundent on subsp. *indica.*

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21. DISTRIBUTION OF THE KEELED BOX TURTLE *PYXIDEA MOUHOTII* (GRAY)

The keeled box turtle *Pyxidea mouhotii* (Gray) is one of the several little-known terrestrial emydid turtles inhabiting the tropical forests of south and south-east Asia. It is identifiable by its conspicuously flat-topped tricarinate shell, weak plastral hinge, deeply serrated posterior marginals and presence of tubercles at the base of the tail and on the thighs.

The types of *Pyxidea mouhotii* were collected by the artist-explorer Henri Mouhot from the Laos mountains on the 'Annam - Siam border' (Gray 1862) and are at the British Museum (Natural History), London. Pritchard (1979) gives the distribution of the species as Laos, Viet Nam and Hainan Island, while Pope (1935) reports it from Namfong in Hainan, China, mentioning that the species is also known from Indo-China, including Tongking. Both the authors omit Assam, from where an earlier worker, Smith (1931) had reported the species. Wirot (1979) mentions of the occurrence of the turtle from the northern region of Thailand, from the Chiang Rai, Chiang Mai and Mae Hong Son Provinces.

Several specimens of *Pyxidea mouhotii* have been collected from India, and are now in the National Zoological Collection, Zoological Survey of India, Calcutta, and the British Museum (Natural History), London. Here I present a discussion on the distribution of this little-known species, based on these and other records.

Material at the Zoological Survey of India, Calcutta, collected by Captain Williamson in 1872 include three specimens (Reg. Nos. 14, 708 and 1016) from the Garo Hills presently under Meghalaya and one (Reg. No. 709) whose locality is given as 'Assam'. More recently, a single example (Reg. No. 23923) was collected by a Z.S.I. expedition to Namdapha, Arunachal Pradesh. This specimen was collected on 27.4.1981 from Deban, 27 Km. east from Miao, in the Tirap District, and is an extension of range of *Pyxidea mouhotii* by atleast 350 Km. to the north-east. This example, which was collected from the rocky bank of a stream inside a forest, has distinct tubercles on thigh measuring upto 4 mm.

The British Museum (Natural History), South Kensington, London has a fairly large collection of the species, including the types collected by Mouhot from 'Lao Mountains' and an adult shell, presented by T. C. Jerdon and labelled 'Cachar'? (Reg. No. 70.11.29.53). Smith (1931) mentions of a British Museum specimen which he provisionally referred to the present species. This example, BM(NH) Reg. No. 98.12.20.1, a well preserved hatchling with an egg-caruncle is registered as from 'Eastern Assam hills, probably North Cachar near Barail Range'. Standard measurements of the specimen taken with vernier calipers have been given below :

British Museum (Natural History) Reg. No. 98.12.20.1. Carapace length 39.2 mm., carapace breadth 30.7 mm., plastron length 35.0 mm., shell height 18.85 mm., tail length (vent to tip) 16.75 mm.

As mentioned by Smith (op. cit) the specimen is unusual in several aspects. Perhaps the most striking among these is the tail which exceeds the length of the plastron. However, it matches the description of the species in the possession of a flat-topped, tricarinate shell, markedly serrated posterior marginals, a long and narrow nuchal shield, short but distinct bridge, strongly hooked upperjaw, large shields on the posterior part of the forehead and on the forelimbs and half-webbed digits.

The carapace of this unusual specimen is chocolate-brown, the vertebral keel brownish-yellow edged with dark brown. The plastron is chrome yellow with a single large chocolate-brown patch in the middle, and inframarginals of the same colour, as opposed to the usual plastral pattern of dark brown spots on a yellow-brown background. The head is brown with a yellow spot and streak behind each eye.

The known range of the species is therefore Tirap District, Arunachal Pradesh and Garo Hills, Meghalaya, possibly also North Cachar Hills, Assam, in India. Extralimitally, it is known from Chiang Rai, Chiang Mai and Mae Hong Son Provinces in Thailand, Laos, Vietnam and Namfong in Hainan, China.

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22. BREEDING THE KING COBRA (*OPHIOPHAGUS HANNAH*) IN CAPTIVITY

(*With a photograph*)

In December 1982 the Madras Snake Park Trust (MSPT) obtained on breeding loan a 4.0 m, 6.5 Kg. male king cobra (*Ophiophagus hannah* Cantor) from the Mangalore Wildlife Trust in Karnataka to mate with the Park's three six year old females which were born and raised in captivity. Copulation between the male and the smallest of the three females was observed on several occasions in February 1982. Forty five days after the last observed mating this female laid a clutch of 23 premature, unviable eggs under a small mound of bamboo leaves that she had gathered from the floor of the enclosure. Another female that had appeared to be gravid did not lay any eggs. Our first attempt to breed king cobras in captivity was therefore unsuccessful.

In November 1983 the experiment was tried again with the same male. Matings occurred in February and March 1984 and resulted in

the smallest female laying again, this time a total of 24 eggs of which 6 were unshelled, 6 shelled but infertile and 12 fertile. The eggs were discovered by the keeper on 26 April 1984 at 8.30 a.m. and were presumed to have been deposited the previous night. The eggs were situated in a saucer-like depression in the enclosure floor and covered over by a small mound of bamboo leaves gathered by the female. A week later the eggs were removed for artificial incubation as conditions inside the enclosure were not ideal for this purpose. 11 out of the 12 fertile eggs (i.e., 92% of the fertile eggs) hatched successfully between 28 June and 1 July 1984 after an incubation period of 63 to 66 days. This is perhaps the first time that this species, the longest venomous snake in the world, has been bred in captivity outside the united States of America.

Introduction

An excellent review of the literature pertaining to the reproductive habits of the king cobra is given by Oliver (1956) who also documented in considerable detail the captive breeding exercises for this species at the New York Zoological Park in the United States (Oliver 1956 and 1957). Burchfield (1977) reported on the captive breeding efforts at the Gladys Porter Zoo in Texas.

Since our observations on courtship, mating and oviposition compare closely to the accounts given by the authors cited above I have avoided treating these aspects in detail here. The emphasis of this paper is on care of animals, incubation techniques for eggs and rearing of young under conditions prevailing in Indian zoos.

TABLE 1

BREEDING RECORDS FROM OTHER INSTITUTIONS

Institution	Year	Mating	Oviposition	Eggs	Hatchlings	% Success	Source
New York Zoo,	1955	10 Mar.					
U.S.A.		14 Mar.					
		18 Mar.	24 Apr.	41	14	34%	Oliver, 1956
	1956	16 Jan.					
		17 Jan.					
		26 Jan.					
		8 Mar.					
		14 Mar.	24 Apr.	51	0	0	Oliver, 1956
	1957	—	24 Apr.	56	39	70%	Oliver, 1957
Gladys Porter							
Zoo,	1974	8 Mar.	28 Jun.	28	19	68%	Burchfield, 1977
Texas, U.S.A.	1975	26 Apr.	17 Jun.	28	0	0	Burchfield, 1977

TABLE 2

BREEDING DATA (MSPT): MATING

Mating	Time	Duration	Female No.	Temperature
23.2.83	0745 Hrs.	45 min.	3	21°C
26.2.83	1005 Hrs.	67 min.	3	26°C
06.3.83	1400 Hrs.	45 min.	1	26°C
11.2.84	0600 Hrs.	95 min.	3	21°C
13.3.84	0745 Hrs.	45 min.	?	21°C

TABLE 3

BREEDING DATA (MSPT): EGGS

Female No.	Oviposition	Gestation	No. of eggs	Incubation	Date of hatching
3	14 Apr. 1983	45 days	23	—	eggs unviable
3	19-25 Apr. 1984	66 days	24	63-66 days	28.6–1.7.84

History of the MSPT king cobras:

The three female king cobras are the survivors of a clutch of 20 eggs collected from a wild nest 100 m from a mangrove in Panighat in the Andaman Islands. The eggs were resting on a compressed pad of bamboo leaves, one inch thick and covered over by a mound of bamboo leaves 12 inches high and 36 inches in diameter. The female was in attendance, resting coiled over the nest mound. She measured 7 feet in total length and did not display any sign of aggression or resistance at being captured. The average measurement of the eggs was 65 mm × 30 mm. A single egg was cut open at the nest site to reveal a fully developed embryo measuring 33.5 cm. Air temperature measured at the nest site at 0600 hrs. and 1800 hrs. were 26°C and 29°C respectively. Nest temperature at 0600 hrs. was 28°C, 2°C higher than the surrounding air temperature.

The female and her clutch of eggs were brought back to MSPT where 19 of the 20 eggs hatched beginning on 8th July 1976, 23 days after collection. Average total length of the hatchlings was 45 cm. All the hatchlings sloughed for the first time between 15 and 18 July, 7 to 10 days after hatching. From 20 July onwards they were offered a variety of food including hatchling water snakes (*Xenochrophis piscator*, *Atretium schistosum*) and striped keel backs (*Amphiesma stolata*), a common grass snake. However, all except the three females died within six months of their birth. (Romulus Whitaker, pers. comm.)

Housing:

The three surviving females, now over 10 years old, measure between 3.0 and 3.5 m in length. From the slight differences in their size and hood markings it is possible to distinguish them as snakes 1, 2 and 3. Until two years of age they were housed in individual boxes, 6 feet × 1 ft. × 1 ft. in a semi-darkened, air-cooled room. In 1979 they were put on public display, one at a time, housed in a glass fronted wooden enclosure measuring 6 ft. × 3 ft. × 3 ft. This cage had a small door at the back which led into a similar sized cage inside the air cooled room. The snake on display was thus free to choose the enclosure of its preference and went through a gradual acclimatisation to the local climate.

In 1981 a bigger enclosure was built to accomodate all three females at the same time. This, the present arrangement, consists of two interconnected enclosures placed side by side (henceforth to be referred to as units A and B). Unit A is a glass fronted room approximately 12 ft. × 5 ft. × 6 ft. with a keeper entrance at one end. A small door at the opposite end communicates with unit B which is approximately 7 ft. × 6 ft. × 6 ft. This enclosure is constructed of weld mesh and has a keeper entrance at the other end.

Unit A has a mud floor covered with a thick layer of dry bamboo leaves. A desert air cooler placed outside the enclosure maintains the summer day temperature inside the enclosure at 26° to 30°C. Two cement bowls provide drinking water. Unit B has a thick layer of soil and is landscaped with grass, logs, rocks

and plants. A creeper (*Vernonia* sp.) on the roof partially shades the enclosure.

The snakes spend the cooler hours of the day during summer and most of their time during the cooler months of the year basking or resting in Unit B. Apparently because they are free to move at will from one enclosure to the other to suit their thermoregulatory requirements the snakes seem to have adjusted well to the predominantly hot climate of Madras.

Feeding:

The MSPT king cobras are fed once a week. The preferred, and hence proffered, food item is chequered keelback water snakes (*Xenochrophis piscator*). The water snakes fed to the king cobras are normally quarantined for a week prior to the feeding date and dosed with Mebendazole, a broad spectrum anti-helminth, as a precautionary measure. The snakes are fed alive but always under the supervision of the keeper to prevent any mishaps.

Breeding notes: *egg incubation*

The following procedure, adopted for incubation of the 1984 clutch of king cobra eggs, has proven its worth in the incubation of the eggs of several species of snakes.

The female was first removed from her position on the nest mound (the MSPT king cobras are quite tame). After being uncovered but before being removed the eggs were marked on top with a lead pencil to ensure that they could be reoriented properly in the incubator. The eggs were then measured and weighed.

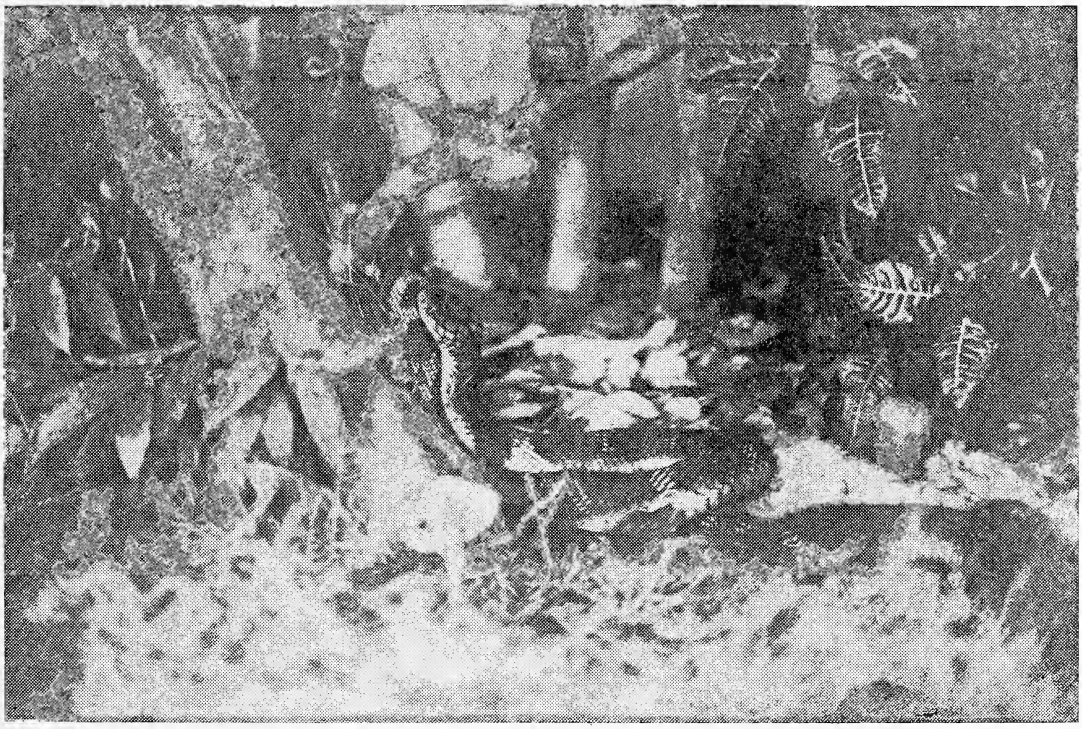

Photo. 1. King Cobra mating.

TABLE 4

EGG MEASUREMENTS

		Length	Diameter
Mean	:	56.8 mm	42.6 mm
Minimum	:	48.0 mm	24.0 mm
Maximum	:	64.5 mm	38.0 mm

Fertility was assessed by candling. This technique, long in use in poultry management, is highly useful to the reptile captive breeder. A circular piece of tin or card with a small centrally placed hole in it is fitted in front of an ordinary table lamp. The light is switched on in a darkened room and the egg is held in front of the hole. Blood vessels and other signs of embryonic development can be seen in fertile and developing eggs, even within a week after they are laid. The alternative technique to guage fertility of a clutch of eggs by cutting open one or two is, as Ross (1980) rightly points out, useless and wasteful "in as much the egg opened, if fertile, may actually be the only fertile egg, and if infertile, may be the only infertile egg". In our experience candling works with the eggs of all species of snakes in our collection with the exception of python eggs whose shells are too thick for the light to show through.

The fertile eggs were divided into three groups of four eggs each and each group was placed inside a polythene bag, over a substrate of damp cotton wool or newspaper. The bags were fully inflated by mouth and closed tightly by means of rubber bands. Further inflation was done as and when required. The substrate was also wetted when required (Dattatri 1985). All the plastic bags were placed inside a cross-ventilated wooden box, over a layer of bricks.

A desert air cooler placed two feet away kept the air inside the wooden box at the right temperature and humidity. If the temperature within the box had to be further lowered, the bricks on the floor of the box were wetted. The entire box was elevated on a stool, the legs of which stood in small basins of water to deter ants from climbing into the box. Temperature inside the box was monitored constantly and recorded three times a day. Humidity inside the box was maintained at 75 to 90% as measured by a cyclometer. The cotton wool substrate had to be replaced on two occasions due to growth of fungus.

A close watch was kept on the eggs and when the first slit appeared in one of them they were all removed to plastic bread boxes to hatch. The hatchlings were measured, weighed, sexed and placed one each in a glass fronted wooden box 15 inches × 8 in. × 7 in. Each box had a layer of newspaper on the floor, covered by a layer of green leaves and a thin green leaved branch, giving the hatchlings a choice of substrates to rest upon or under. A small bowl of water was provided for drinking. In addition a little water was sprayed on the leaves of the branch, as many young snakes prefer drinking this way.

TABLE 5

INCUBATION TEMPERATURE (°C)

9.00 Hrs.			12.00 Hrs.			18.00 Hrs.		
Average	Min.	Max.	Average	Min.	Max.	Average	Min.	Max.
29.5	28.5	31	29.2	27.8	31.5	29.3	27	32

TABLE 6

HATCHLING MEASUREMENTS

Total length (N=6)	Weight (N=11)
Average : 46.7 cm.	14 gms.
Minimum : 45.5 cm.	99 gms.
Maximum : 49 cm.	17 gms.

All eleven hatchlings shed their first skins between 7 and 9 days after hatching. Commencing on day 10 a variety of food was offered to them. This included small sized skinks — juvenile *Mabuya carinata, M. bibroni* and *Riopa punctata* — and hatchling snakes — *Xenochrophis piscator, Atretium schistosum, Amphiesma stolata* and *Cerberus rhynchops*. However, all the hatchling king cobras refused to feed. Some responded well initially to assisted feeding — i.e., they swallowed dead snakes which were placed in their mouths. The others were force fed as a last resort. Despite these efforts the baby king cobras died one after the other, for no apparent reason, within two months after hatching.

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23. A LIST OF THE SNAKES OF THE BHAVNAGAR DISTRICT, GUJARAT STATE

Bhavnagar District is situated along the Bay of Cambay, at *c.* 21.46°N latitude, 72.11°E longitude. The area is arid and dry with scanty rainfall and the forests are dry thorny deciduous the rocky and hilly area of forest land is estimated to be about 15061.67 hectares in this District, while 15928.07 hectares are grasslands.

Family TYPHLOPIDAE

(1) *Typhlops porrectus,* Stoliczka, 1871
Common, seen under stones, logs and moist soil in gardens and also occasionally in side houses.

(2) *Typhlops braminus* (Daudin, 1803)
Very common.

Family: BOIDAE

(3) *Python molurus* (Linnaeus, 1758)
One young specimen was collected on Palitana hills.

(4) *Eryx conicus,* (Schneider, 1801)
Very common. A female in captivity delivered three young in August.

(5) *Eryx johni* (Russell, 1801)
Common.

Family: COLUBRIDAE

(6) *Lycodon striatus* (Shaw, 1802)
Uncommon.

(7) *Lycodon aulicus* (Linnaeus, 1754)
Fairly common, commonly found in houses.

(8) *Lycodon flavomaculatus,* (Wall, 1907)
One specimen seen, was from the compound of Alcock Ashdown-Barges Co., at Bhavnagar.

(9) *Oligodon arnensis* (Shaw, 1802)
Common, A banded kukri snake laid two eggs in captivity in the month of November, The eggs were 33 × 40 mm.

(10) *Oligodon taeniolatus* (Jerdon, 1853)
Common. I collected one gravid female in August.

(11) *Sibynophis subpunctatus* (Dum. & Bibr. 1854)
A male collected from Amargadh, was 33.5 cm. in length (*Sibynophis* is a genus of hill snakes but I collected one from the middle of Jamnagar City, I also collected a specimen from Barda hills).

(12) *Amphiesma stolata* (Linnaeus, 1758)
Uncommon.

(13) *Xenochrophis piscator* (Schneider, 1799)
Very common. I collected one specimen from Desainagar, Bhavnagar, which showed unusual scales on the head, Right side supralabials nine, 4th and 5th of the same size and touch the eye. Temporals 2+2 the first two are longer than posterior two. Left side supralabials eight only 4th one touches the eye 4th is bigger than 5th, Temporals 2+2 first two are smaller and short than the posterior two.

(14) *Acrochordus granulatus* (Schneider, 1799)
Common on Bhavnagar shore and Shetrunji river estuaries.

(15) *Elaphe helena* (Daudin, 1803)
Very common. I collected 25 specimens of this species from densely populated areas in central area of Bhavnagar city. One specimen was collected from the Railway Station by Shri Shukla which was totally golden yellow with yellow marking, the pattern being the same as in ordinary trinket snake. The eyes were pink red.

(16) *Ptyas mucosus* (Linnaeus, 1758)
Common.

(17) *Argyrogena fasciolatus* (Shaw, 1802)
Common, a gravid female was collected from the Alcock Ashdown & Co. Ltd. at old port Bhavnagar had a total length 180.0 cm. This is the longest specimen ever recorded. I got 23 eggs from this female. The animal died two days after collection.

(18) *Dendrelaphis tristis* (Daudin, 1803)
Uncommon.

(19) *Psammophis leithi* Gunther, 1869
A specimen was collected from Bhavnagar University campus.

(20) *Boiga trigonata* (Schneider, 1802)
Common.

Family: ELAPIDAE

(21) *Bungarus caeruleus* (Schneider, 1801)
Common.

(22) *Naja naja naja* (Linnaeus, 1758)
Very common.

(23) *Enhydrina schistosa* (Daudin, 1803)
Common along the shores of Bhavnagar District.

(24) *Hydrophis spiralis* (Shaw, 1802)
Common.

(25) *Hydrophis cyanocinctus* Daudin, 1803
Common.

Family: VIPERIDAE

(26) *Echis carinatus* (Schneider, 1801)
Common, The longest specimen recorded

was 78.8 cm in length (Daniel 1983). In my collection a female was collected from the compound of Alcock Ashdown & Co. Ltd., at old port Bhavnagar had a record length of 92.0 cm.

26 species of snakes contained in 20 genera belonging to 5 families have been recorded from various parts of Bhavnagar District.

Two species are being recorded for the first time from Saurashtra region of Gujarat State, namely yellow spotted wolf snake (*Lycodon flavomaculatus*) and Dumerils black headed snake (*Sibynophis subpunctatus*). In two species saw-scaled viper (*Echis carinatus*) and Banded racer (*Argyrogena fasciolatus*) the record length specimen have been recorded.

More than 20 species of snakes were collected by me are from Bhavnagar city area only. The Trinket snake (*Elaphe helena*) is commonly found in forest, fields and other places away from the human population. But to our surprise, we have collected about 25 specimens from the City area.

As it is important from the human point of view, data on the deaths recorded due to snake bites were collected from the statistical section of the Health Department, Civil Hospital, Ahmedabad for the years 1979 to 1981 (Table 1). It is evident from the figures that the people in rural area are still following their old belief and customs and very few go to hospitals for snake bite treatment.

TABLE 1

SNAKES BITE DEATHS IN GUJARAT (DISTRICT-WISE)

District	1979 Number in area		1980 Number in area		1981 Number in area	
	Rural	Urban	Rural	Urban	Rural	Urban
1	2	3	4	5	6	7
(1) Ahmedabad	7	1	13	1	24	1
(2) Amreli	18	3	12	10	40	3
(3) Banaskantha	20	5	16	1	25	3
(4) Bharoch	15	4	23	1	34	—
(5) Bhavnagar	10	22	28	15	33	29
(6) Dang	16	—	22	—	—	—
(7) Gandhinagar	5	—	—	—	—	—
(8) Jamnagar	13	10	15	9	40	4
(9) Junagadh	21	19	20	19	22	25
(10) Kheda	30	13	20	14	47	11
(11) Kutch	3	2	16	2	28	7
(12) Mehsana	1	5	14	13	32	10
(13) Panchmahals	16	4	13	9	17	1
(14) Rajkot	17	14	19	10	35	10
(15) Sabarkantha	15	—	5	1	13	3
(16) Surat	26	1	10	10	29	4
(17) Surendranagar	4	7	8	2	18	8
(18) Vadodara	15	20	31	7	43	7
(19) Valsad	9	2	27	7	32	1
Total	261	132	312	131	512	127

TABLE 2

SNAKES COLLECTED FROM BHAVNAGAR CITY AREA (BY R. V. VYAS).
NUMBERS GIVEN IN PARENTHESIS ARE COLLECTED BY SHUKLA

	Common Name	1980	1981	1982	1983
1	2	3	4	5	6
(1)	Slender worm snake	1	—	—	1
(2)	Common worm snake	2	1(4)	1(2)	2(1)
(3)	Common sand boa	2(2)	5	2	3
(4)	Red sand boa	3	2(1)	—(1)	1
(5)	Barred Wolf snake	—(4)	—(7)	1(16)	1(24)
(6)	Common Wolf snake	10	15	5	6
(7)	Russell's Kukri Snake	2	3	1	2
(8)	Common Kukri Snake	4(1)	4	1	—
(9)	Striped keelback	1(1)	—(2)	—(2)	—(1)
(10)	Common trinket snake	12(3)	8(1)	3(5)	5(13)
(11)	Banded racer	8(2)	5	2	1
(12)	Rat snake	15(6)	10(6)	3(16)	1(11)
(13)	Checkered keelback Water snake	25(1)	20(49)	10(34)	8(28)
(14)	Common bronzeback Tree snake	2	5(2)	3(2)	5(2)
(15)	Common Cat snake	6(1)	1	1(1)	3(1)
(16)	Common krait	2	1	—(2)	1(2)
(17)	Indian Cobra	30(8)	18(35)	14(32)	12(43)
(18)	Saw-Scaled Viper	5	3(2)	2(1)	3(1)
	Total	130(29)	101(109)	49(114)	55(127)

As an act of conservation Mr. Shukla and his family and I collect snakes from the city (Table 2) as and when we get reports from the public and after identifying-measuring release them away from the residential areas of the city.

ACKNOWLEDGEMENTS

I take this opportunity to express my sincere thanks to Dr. B. H. Patel, Prof. & Head of the Department of Zoology, Sir P. P. Institute of Science, Bhavnagar University, Bhavnagar, under whose able guidance. I had the incentive to go ahead with my research work. I also wish to convey my thanks to the Director, Department of Health, Statistical section, Civil Hospital-Ahmedabad for providing me the statistical record of death due to snake bite and to the Curator, Bombay Natural History Society, Bombay for extending kind help in identifying snakes. I am also thankful to the President, Wildlife Conservation Society, Bhavnagar for helping in all aspects of my work.

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24. A NOTE ON THE BREEDING HABITS OF JERDON'S RAMANELLA, *RAMANELLA MONTANA* (JERDON, 1854)

Ramanella montana is not an uncommon microhylid in the Bombay area, at the beginning of the monsoon, but rarely seen during the other seasons of the year. I had the opportunity of studying their breeding habits at the Sanjay Gandhi National Park, Borivli, during the monsoon of 1982-83.

Breeding season and sites: The species starts to breed in the early monsoon and the breeding activity is very brief and is over within a period of 3 to 4 days. The breeding congregation of a good number of the frogs was seen in the Dahisar river of the park which has at this time a gentle flow of water. However, some of the frogs were also observed calling from a rain pool.

Call: On 20th June 1983 at 1220 hrs while it was raining heavily I heard the frogs calling from the stream. The current was very gentle and there were some stagnant pockets. The water depth was *c* 75 cm. The atmospheric temperature was 29.1°C and that of the water 28.0°C. The frogs called from the water close to the bank. The call could be syllabilised as *brong...brong...brong.* The single small vocal sac looks like a white bubble when fully inflated. On 24th June 1983 at about 1200 hrs the species was observed on both banks of the stream in heavy rain. The current was strong and the water turbid with the temperature at 27.7°C. Litter in the form of twigs had gathered at the base of the trees on the edge of the stream. The frogs hid under the litter. Some sat above the waterlevel and were calling while others sat on the slender branches that overhung and touched the running water. On an average each call sequence was for 114 seconds. The chorus was very coarse. They were very wary of intruders and when I approached the bank, the frogs ceased calling though those on the opposite bank continued calling.

Amplexus: The amplexus was in the water and was axillary the male's forelimbs holding the female at her armpit. They were swimming freely. They swam slowly and could be caught, and though they were disturbed they continued in amplexus. A pair which was kept in a jar started laying eggs at 1145 hrs. The female lifted up the cloaca and released the eggs. After 10 seconds she again lifted up the cloaca and released more eggs. This process was continued for 15 minutes. At 1201 hrs the male released the female.

Spawn: The egg mass was obtained in the stream but in water that was more or less stagnant and had a depth of about 15 cm. The spawn was plate like with a diameter of 95 mm and the eggs similar to mustard seed were

embedded in it. The animal pole which was black in colour was exposed at the top. The eggs which were surrounded by gelatinous substance measured 1 mm in diameter.

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25. ON THE SYNONYMY OF *DANIO FEEGRADEI* HORA, 1937 FROM BURMA (PISCES: CYPRINIDAE)*

(*With a text-figure*)

Danio feegradei Hora was discovered and described from a single specimen from Burma. This species is proposed to be synonymized with *Danio dangila* (Hamilton 1822) in this communication.

INTRODUCTION

Hora (1937) described a new species, *Danio feegradei* based on a single specimen from Sandoway, Lower Burma. He remarked that this species falls intermediate between the genera *Danio* and *Brachydanio* in having 9 branched dorsal fin rays (2/9) and a complete lateral line. Hora & Mukerji (1934) gave a synopsis of the Indian and Burmese species of the cyprinid genus *Danio* Hamilton, including all the species then known in the two subgenera *Danio* and *Brachydanio*. Species having 12-16 branched dorsal fin rays and a complete lateral line were included under the subgenus *Danio*, and species with 7 or less branched dorsal fin rays and incomplete or absent lateral line were included under the subgenus *Brachydanio*. They included 8 species under the subgenus *Danio*. My revisionary study of the cyprinid genus *Danio* shows that 5 species are known *viz.*, *D. dangila* (Hamilton, 1822), *D. aequipinnatus* (McClelland, 1839), *D. kakhienensis* Anderson, 1878, *D. naganensis* Chaudhuri, 1912 and *D. neilgherriensis* (Day, 1867) out of the 8 species in which there are 8 to 11 branched dorsal fin rays. Comparative data of these species are shown with special reference to the number of their dorsal and anal fin rays, barbels and lateral line in Table 1. Jayaram (1981) included *D. feegradei* among the members of the subgenus *Brachydanio* without any comment for this inclusion. This species is proposed here as a synonym of *D. dangila* in view of their striking similarities in proportional measurements, meristic counts, squamation, complete lateral line and two pairs of long barbels.

A brief description of *Danio feegradei* Hora is given here.

Danio feegradei Hora

Danio feegradei Hora, 1937, *Rec. Indian Mus.*, *39*(4): 325-327, text-fig. 3 (type-locality: Sandoway, Lower Burma). (Fig. 1).

* Part of Ph.D. thesis accepted by the University of Calcutta, Calcutta.

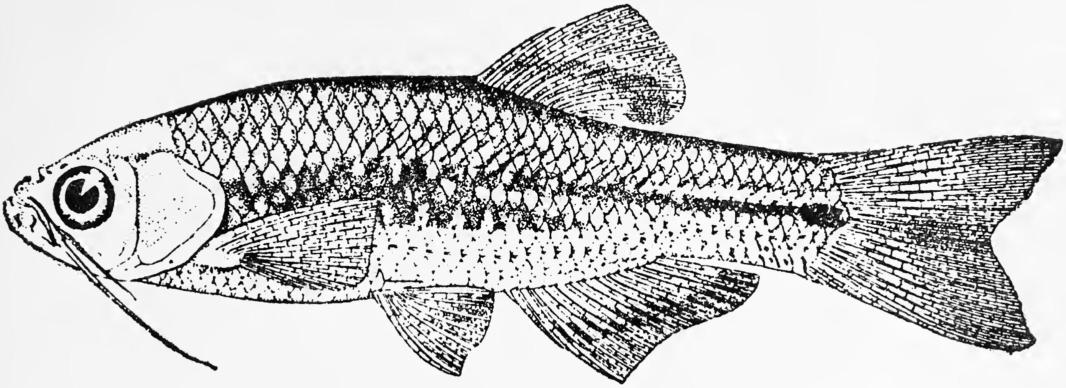

Fig. 1. *Danio feegradei* Hora.

Material: *Holotype*: 43 mm. SL., Zoological Survey of India, Calcutta Reg. No. F 12477/1. Locality: Sandoway, Lower Burma. Coll.: Lieut. E. S. Feegrade. Date of collection: June-August, 1936.

Description: Head length and body depth 3.90, predorsal distance 1.72, prepelvic distance 2.26, caudal peduncle length 4.77 in standard length. Least depth of caudal peduncle 7.16 in standard length, 1.50 in its length. Depth of head 1.37 and width of head 1.83 in head length. Eye diameter 3.66 in head length, 1.60 in interorbital width. Snout length 4.40 in head length, 1.60 in interorbital width. 2 pairs of well developed barbels, anterior or rostral pair shorter than head and posterior or maxillary pair equal to head length.

Scales: Lateral line complete, covering 39 scales, lateral transverse series of scales at the origin of pelvic fin 10; scales between the lateral line and base of pelvic fin $2\frac{1}{2}$. Predorsal scales 18 and circumpeduncular scales 14.

Fins: D. ii, 9; A. iii, 12; P. i, 11; V. i, 7; C. 19.

Dorsal fin originates nearer to the base of caudal fin than to the tip of snout. Pelvic fin commences on a vertical anterior to dorsal fin. Both the pectoral and pelvic fins possess scaly flap at their bases on superior margins. Pectoral fin reaches base of pelvic fin. Caudal fin emarginate.

Body part proportions of *D. feegradei* and *D. dangila* are shown in table 2.

Colour in alcohol (from Hora, 1937): Pale olivaceous, dusky dorsal surface with a black streak along the mid-dorsal line. In the middle of the fish there is a black band which is considerably broader anteriorly and terminates posteriorly in a somewhat darker spot at the base of caudal fin. Anteriorly black band is marked, both above and below, with short pearl-white bands and in the posterior region there is a white longitudinal band above it. Dorsal and anal fin rays marked with longitudinal bands across them.

The present state of this specimen of this species preserved in the collection of the Zoological Survey of India, Calcutta is damaged and decolourized; therefore, coloration of the species could not be studied.

Distribution: Burma: so far far known only from Sandoway, Lower Burma.

Discussion

Examination of the type specimen of *D. feegradei* preserved in the collection of the

TABLE 1

MERISTIC COUNTS OF 5 SPECIES OF *Danio* WITH SPECIAL REFERENCE TO NUMBER OF DORSAL AND ANAL FIN RAYS AND ALSO BARBELS AND LATERAL LINE

Name of species	D. fin rays	AA. fin rays	Barbels	Lateral line
D. aequipinnatus	13–15 (2–3/11–12)	16–18 (2–3/14–16)	2 pairs, short	Complete
D. dangila	11–13 (2/9–11)	14–17 (2–3/12–15)	2 pairs, long	Complete
D. kakhienensis	10(2/8)	14(2/12)	1 pair, short	Complete
D. naganensis	10(2/8)	14–15 (2/12–13)	2 pairs, short	Complete
D. neilgherriensis	11–14 (2–3/9–11)	13–14 (2/11–12)	2 pairs, short	Complete

TABLE 2

BODY PART PROPORTIONS OF *D feegradei* AND *D. dangila*

Characters	*D. feegradei*	*D. dangila*
Standard length/Head length	3.90	3.90–4.25
Standard length/Body depth	3.90	3.25–4.00
Standard length/ Predorsal distance	1.72	1.62–1.76
Standard length/ Prepelvic distance	2.26	2.09–2.40
Length of caudal peduncle/ Depth of caudal peduncle	1.50	1.20–1.66
Head length/Eye diameter	3.66	3.00–4.00
Head length/Snout length	4.40	4.00–4.50
Lateral line scales	39	36–40
Predorsal distance	18	16–18
Circumpeduncular scales	14	12–14
Transverse row of scales	10	9–10
Dorsal fin rays	11 (2/9)	11–13 (2/9–11)
Anal fin rays	16 (3/12)	14–17 (2–3/12-15)
Lateral line	Complete	Complete
2 pairs of long barbels	Present	Present
Distribution	Burma	India, Burma and Nepal

Zoological Survey of India, Calcutta, reveals that this species is strikingly similar to *D. dangila.* From comparison of a large series of specimens of *D. dangila* from different localities of India and Burma with *D. feegradei,* it appears that there is no character that can be considered as differentiating this species from *D. dangila* as shown in Table 2. An analysis of the characters shown in Table 1 also reveals that this species comes very near *D. dangila* among the members of the genus *Danio* by the possession of a complete lateral line, 9 branched dorsal fin rays and 2 pairs of long barbels. Besides this, taxonomically *D. feegradei* should be included among the members of *Danio* and not in *Brachydanio* as was done by Jayaram (1981), since it has 11(2/9) dorsal fin rays and a complete lateral line. Myers (1953) also remarked that *D. feegradei* can be easily identified as a member of *Danio* by the possession of 9 branched dorsal fin rays and a complete lateral line. Therefore, in view of the above mentioned characters it is proposed here to synonymize *D. feegradei* with *D. dangila.*

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ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
October 4, 1986.

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26. OBSERVATIONS ON INDIAN TRABUTININI SILVESTRI AND PHENACOCCINI SULC (PSEUDOCOCCINAE: PSEUDOCOCCIDAE: HOMOPTERA)

The present study deals with the observations on 6 species representing 6 genera belonging to the tribes Trabutinini and Phenacoccini in India. The two tribes are distinctly separated from each other by the following key characters:

1. Quinquelocular pores and dentate claws entirely absent; body enclosed within the ovisac .... Trabutinini Silvestri
— Quinquelocular pores or dentate claws or both present; body not enclosed within the ovisac ... . Phenacoccini Sulc

Tribe TRABUTININI Silvestri

This tribe is represented by a single genus *Naiacoccus* Green from India.

Genus *Naiacoccus* Green

Ferris (1950) placed this genus in a group including the genera *Amonostherium* Morrison, *Trabutina* Marchal and *Nipaecoccus* Sulc. But Bodenheimer (1953) placed it under subfamily Trabutininae. This genus is represented by a single species from India.

Naiacoccus serpentinus Green

In the field, adult females of this species are easily recognized by the presence of an enormously elongated (about 20 mm long) white tubular ovisac in the form of a simple twisted loop within the anterior extremity of which the insect lies concealed. We have observed a heavy infestation of this species on *Tamarix articulata* at Hathras (Aligarh).

Material examined: 5 ♀, INDIA: Uttar Pradesh, Aligarh, Hathras, on *Tamarix articulata* Wall., 26.iv.1978; 8 ♀, Mathura, Farah, 5.v.1978 (*R. K. Avasthi*).

Tribe PHENACOCCINI Sulc

Koteja (1974) recognized Trabutininae as subfamily of Pseudococcidae and placed under

it the group names, Phenacoccinae Sulc, Coccurini Borchsenius, Ceroputo + Nairobia sections of Afifi, and Putoidae Beardsley. According to him "the group name Trabutininae had priority over all other names." In the present paper Phenacoccini is treated as a distinct tribe of Pseudococcinae and is represented by 6 genera from Indian region which are separated by the following key characters:

KEY TO INDIAN GENERA OF PHENACOCCINI SULC, BASED ON ADULT FEMALES

1. Dorsum without longitudinal series of prominences bearing stout conical or large truncate spines, except on cerarii 2
— Dorsum with longitudinal series of prominences, each bearing variable number of stout conical or large truncate spines which resemble with the cerarian spines (Ferris, 1954: fig. 40) .... *Coccidohystrix* Lindinger

2. Crateriform ducts absent 3
— Crateriform ducts present, each with the orifice at the apex of a sclerotized prominence and often with one or more setae attached to the base of the duct prominence (Avasthi & Shafee, 1982: fig. 1) .... *Heliococcus* Sulc

3. Quinquelocular pores absent on dorsum; trilocular pores present throughout venter; claw with denticle; antennae 8- or 9-segmented 4
— Quinquelocular pores present on both surfaces; trilocular pores confined near spiracles only; claw without denticle antennae 6- or 7-segmented (Williams, 1970: fig. 3) .... *Brevennia* Goux

4. Cerarii anterior to anal lobe not formed upon a sclerotized plate or area.................... 5
— Cerarii including anal lobe formed upon a sclerotized plate or area bearing more than 6 enlarged setae or spines (Williams, 1970: fig. 21; Ali, 1975: fig. 1) .... *Birendracoccus* Ali

5. Most of the cerarii with 2 and few with 3-5 conical spines (Avasthi & Shafee, 1978: fig. 1) .... *Phenacoccus* Cockerell
— All cerarii with numerous truncated spines (Ferris, 1954: fig. 41; Avasthi & Shafee, 1983: fig. 1) .... *Rastrococcus* Ferris

Genus *Birendracoccus* Ali

Ali (1975) assigned this genus in a group of genera having all the cerarii with basal area sclerotized. The presence of numerous multilocular pores on venter of posterior abdominal segments may be an significant character for separating *Birendracoccus* from *Puto* Signoret. This genus is represented by a single species from India.

Birendracoccus saccharifolii (Green)

This species is a vector of spike disease on sugarcane (Ali 1962) and is a major pest in Bihar (Williams 1970).

Material examined: 10 ♀, INDIA: Uttar Pradesh, Aligarh, on leaf sheath of *Saccharum officinarum* Linn., 7.ix.1978 (*R. K. Avasthi*).

Genus *Brevennia* Goux

The genus is represented by a single species, *B. rehi* (Lindinger) from India. It is redescribed and illustrated by Williams (1970). It is known to us only by the descriptions of earlier workers.

Genus *Coccidohystrix* Lindinger

Only a single species has so far been included in this genus from India.

Coccidohystrix insolitus (Green)

The species is widely distributed throughout India infesting about 13 different species of plants (Ali 1970). We have observed it for the first time infesting *Solanum hispidum* and *Euphorbia pulcherrima* at Aligarh. Both nymphs and adults were usually found on undersurface of the leaves and their infestation causes serious damage to the plants.

Material examined: 2 ♀, INDIA: Bihar, Gaya, on *Achyranthus aspera* L., 25.x.1969 (*S. Adam Shafee*); 4 ♀, 10 ♂, Uttar Pradesh, Aligarh, on *Solanum melongena* L., 2.viii.1977; 3 ♀, 2 ♂, on *Solanum hispidum*, 24.x.1977; 2 ♀, 3 ♂, on *Euphorbia pulcherrima* Willd., 24.xi.1977; 6 ♀, 6 ♂, on *Abutilon indicum*, 5.xii.1977; 5 ♀, Tamil Nadu, Coimbatore, on *Abutilon indicum* and *Achyranthus aspera* L., 27.iii.1979 (*R. K. Avasthi*).

Genus *Heliococcus* Sulc

The genus *Heliococcus* (with *H. singularis* Avasthi & Shafee) was reported for the first time from India by Avasthi & Shafee (1982).

Heliococcus singularis Avasthi & Shafee

Material examined: *Holotype* ♀, INDIA: Andhra Pradesh, Prakasam, Chirala, on *Cupressus* sp., 1.iv.1979 (*R. K. Avasthi*).

Genus *Phenacoccus* Cockerell

Ali (1970) catalogued a single species *P. saccharifolii* Green from India which was later designated by him (1975) as type-species of his new genus *Birendracoccus*. Here we have assigned only a single species of Indian origin under this genus.

Phenacoccus indicus (Avasthi & Shafee), comb. nov.

Peliococcus indicus Avasthi & Shafee, 1978: 905.

The species agrees in every respect with the generic diagnosis given by Ferris (1950), McKenzie (1962), Williams (1970) for the genus *Phenacoccus*. The absence of clusters of multilocular pores each with one or more slender tubular ducts near the centre separate it from the genus *Peliococcus* Borchsenius. Therefore, *P. indicus* is transferred to the genus *Phenacoccus*.

Material examined: *Holotype* ♀, *Paratypes* 4 ♀ INDIA: Mysore, Bangalore, Hebbal, on *Prosopis spicigera* L., 29.vi.1968 (*S. A. Shafee*).

Genus *Rastrococcus* Ferris

The genus is represented by four species *R. cappariae* Avasthi & Shafee, *R. iceryoides* (Green), *R. mangiferae* (Green) and *R. ornatus* (Green) from India. The later two species were included in *Rastrococcus* by Ferris (1954) who was of the opinion that the generic diagnosis applies only to the type-species of the genus whereas the other species referred to this genus here have some peculiar characters which need either naming of a new genus or their inclusion in a single genus which is definable with difficulty. However, the absence of dentate claw separate these two from the genus *Rastrococcus* Ferris.

Rastrococcus cappariae Avasthi & Shafee

R. cappariae Avasthi & Shafee, 1983: 103.

Material examined: *Holotype* ♀ *Paratypes* 5 ♀, INDIA: Uttar Pradesh, Aligarh, Naqvi Park, on *Capparis sepiaria* Wall., 2.vi.1977; 4 ♀, Bulandshahar, Danwar, on *Mangifera indica* Linn., 12.vi.1977; 10 ♀, Tamil Nadu, Coimbatore, on *Acacia maniliformis*, *Ceiba pentandra* and *Capparis sepiaria* Wall., 27.iii. 1979 (*R. K. Avasthi*).

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27. STUDIES ON THE BIOLOGY OF *PARNARA NASO* FABR. (LEPIDOPTERA: HESPERIIDAE)

The rice skipper feeds on the rice leaves and occurs throughout the rice growing tract. Rao *et al.* (1970) recorded it in nurseries and planted crops causing varying amounts of damage. *Baoris guttatus* Bada (*Parnara naso bada* M.) was recorded by Kulshreshtha *et al.* (1973) as causing damage to growing rice. Though a large number of references on the occurrence and biology of *Parnara* sp. on rice are available, information on the habits and biology of *P. naso* is scanty. Hence, a detailed study of the biology, larval habits and the common larval parasites was undertaken.

MATERIALS AND METHODS

Females of *P. naso* were collected from rice fields and released in glass chimneys on potted rice plants for egg laying. After hatching of the eggs the larvae were transferred to cut rice

leaves in glass vials (15×15 cm.). Mature larvae were transferred to potted rice plants for pupation. The pupae were kept in glass jars for emergence of adults. Potted rice plants containing larvae and pupae of *P. naso* were placed in rice field for three days to trap the parasites. Later these were clipped and placed in glass vials for emergence of parasites.

Results and Discussion

Egg: Eggs were laid irregularly and singly both on leaf surfaces and stems of rice plants. Ventral side of the leaf was preferred to dorsal side for egg laying. Eggs were round and bluish ash coloured with brownish specs which were absent in infertile eggs. Virgin females also laid eggs but infertile. Diameter of the egg measured 0.86 mm. Incubation period was 4.5 days. On the third day after egg laying the head of the larva appeared as a brownish spot on the top of the egg. Hatching took place during early morning hours. Just after hatching the larvae moved a little away from the egg shell and then turned back again and started feeding on the empty egg shell and later moved downwards along the leaves and entered the folds of tender leaves.

Larva: Five larval instars were observed in the laboratory. Duration and measurements of the different larval instars and pupa are presented in Table 1. Anterior one third region of the freshly hatched larva is light greenish blue and rest of the body dirty white. Head dirty brown. Just behind the head on the dorsal side a narrow dark brown line occurs on the collar. This line was not continuous on the ventral side. Eight to ten hours after hatching larvae fed on leaf blades from inside small leaf folds with lateral notches. Second instar larva was similar to first instar larva except in size and the last abdominal segment being more elongated and projecting. Colour of the head was similar to that of first instar but the median suture was more prominent. The mode of feeding was similar to the first instar larva but the lateral notch on the leaf blade deepened upto the mid rib. Head of the third instar larva is light black and length of the larva increases considerably. In the fourth instar larva, head is brown with whitish markings in a specific pattern. In the fifth instar whitish markings on the head became more prominent. Head pinkish brown. Dorsal side of the head yellowish green. Deep green mid dorsal line from anterior to posterior end of the body prominent. On the third day after moulting, corresponding to the last three pairs of legs and one segment behind that, four oval whitish patches were seen laterally on both sides of the body of the larva. Day by day these patches became more pronounced. Dirty white powder came out of these patches when touched by hand or brush.

Table 1

Morphometric studies on immature stages of *Parnara naso* Fabr.

Stage of the insect	Length in mm	Width in mm	Duration in days
Egg (diameter)	—	0.86	4.50
First instar	2.50	0.52	3.63
Second instar	3.38	0.72	3.12
Third instar	6.30	1.13	3.39
Fourth instar	10.00	1.62	4.06
Fifth instar	19.62	2.46	7.06
Pupa	19.00	—	5.00

Moulting: Six to eight hours before moulting of any instar larva, thorax region appeared swollen and whitish. Collar line became shortened and thickened. Head of the freshly moulted larva was white and no collar line was observed, however, within an hour of moulting head became dark and the collar line reappeared.

Pupa: Before pupation the larva became

soft to touch and looked yellowish green. White incrustations at the posterior lateral side of the abdomen bulged outside. Larvae pupated inside a cocoon constructed by joining two to three leaves together or in between rice stems. Inside the cocoon the pupa was covered by white dust possibly produced by the four pairs of posterior encrustations. Freshly formed pupae were yellowish green and changed to brownish colour afterwards.

Parasites: The following parasites were reared from the field collected larvae of *P. naso*, *Apanteles* sp. incogn., *Apanteles* sp., *Charops bicolor* and *Argarophylax* sp. The following pupal parasites were reared from pupae of *P. naso*, *Thecocarcelia oculata* Baranov, *Brachymeria* sp. nr. *lasus* Walk., *Ischnojoppa luteator* Fabr. and *Xanthopimpla* sp.

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28. DISTRIBUTION OF *DROSOPHILA* SPECIES INHABITING THE TROPICAL RAIN FORESTS OF SAMPAJE GHATS (COORG DISTRICT), KARNATAKA, SOUTH INDIA

INTRODUCTION

Judging from the reports on the occurrence and the pattern of distribution on the members of the genus *Drosophila* from other parts of the world it appears that only little has has been done in the Indian sub-continent. Inspite of the considerable progress made during the past few years (Parshad and Paika 1964, Parshad and Duggal 1965, 1966; Rehman and Singh 1969, Gupta and Ray Chaudhuri 1970, Singh 1970, Jha, Mishra and Singh 1971, Reddy and Krishnamurthy 1971, 1974, 1977; Vaidya and Godbole 1971, 1972, 1973, 1976; Ranganath and Krishnamurthy 1972, Gupta 1973, 1974; Gupta and Singh 1977, Prakash and Reddy 1978) information pertaining to the occurrence and pattern of distribution of the members of the genus *Drosophila* in different eco-geographical regions of the country is not clearly known. For instance many parts of the tropical rain forests of western ghats still await exploration. In view of this, Sampaje ghats near Madikeri, Coorg district (a part of western ghats) has been chosen to get an insight into the *Drosophila* species inhabiting this region. The complex natural habitats of the tropical rain forests of this area with

diverse plant species provide most congenial natural environs for the colonization by members of the genus *Drosophila.* The detailed account of the collection data and the distributional pattern of different species inhabiting Sampaje ghats are presented here.

Materials and Methods

Drosophila survey was carried out at 15 different sites having variable altitudes ranging from 300-1200 metres, along the mountainous slopes of Sampaje ghats. Flies were collected by usual banana bait technique using about ten 250 ml milk bottles at each site.

The flies which are attracted by the fermenting banana were etherised, categorised and the number of each species were recorded. The individual females that could not be identified were isolated into separate media vials. The progenies of such single gravid females were used for detailed morphological, anatomical and cytological investigations to assign them to their respective groups.

Observations

A total of 2340 flies comprising 24 species were collected, of which 23 belong to the genus *Drosophila* and one to the genus *Scaptomyza.* The members of the genus *Drosophila* are represented by three sub-genera namely *Sophophora, Drosophila* and *Scaptodrosophila,* of which majority of them belong to either *Sophophora* or *Drosophila* comprising nearly 98.8% of the total population. While only two species, namely *D. meijerei indicus* and *D. mundagensis* are represented by 2 and 10 individuals belonging to *Scaptodrosophila.* Of the remaining 21 species, 17 species belong to the sub-genus *Sophophora* comprising nearly 55.7% of the total population and only 4 species comprising of about 43.1% belong to the sub-genus *Drosophila.* Among the members of the genus *Drosophila* only four species *D. malerkotliana* (24.7%), *D. takahashii* (13.5%), *D. nasuta* (19.9%), *D. immigrans* (19.3%), comprise nearly 77.4% of the total population. While the other species such as *D. bipectinata* (3.8%), *D. anomelani* (2.4%), *D. jambulina* (1.4%), *D. nagarholensis* (2.1%), were found in moderate numbers and contribute about 9.8% to the total population. The remaining 11.6% of the total population is shared by 15 species represented by a few individuals. Of the 24 species collected 4 species, *D. sampajensis, D. cauverii, D. madikerii* and *D. gangothrii* were new and have been described by us (1980, in press).

The relative abundance of each species encountered in the collections and their distributional pattern along with the altitudes of the collection sites are shown in Table 1. The species composition and the relative numbers of different species in the sites under study vary a great deal inspite of the similarities in the environmental factors such as temperature, humidity, rainfall, vegetation availability of food etc. Perusal of the table reveals that only 4 species, *D. malerkotliana, D. takahashii, D. nasuta* and *D. immigrans* occurred in almost all the sites in considerable numbers, while the other species were found in small numbers and are sparsely distributed.

Discussion

Members of the genus *Drosophila* are cosmopolitan in distribution. However the pattern of distribution depends not only on several ecological factors but also on the colonizing or invasive abilities of the species. Since the environment is not uniform in space and time the numerical variation of different species and their relative abundance in a given area is a common feature. The *Drosophila* investi-

TABLE 1

DISTRIBUTION OF DIFFERENT SPECIES OF *Drosophila* IN SAMPAJE GHATS (COORG DISTRICT), KARNATAKA

LOCALITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Altitude in Meters	300	300	350	400	450	500	600	800	950	950	1000	1000	1050	1100	1200	
1. *D. ananassae*	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	6
2. *D. anomelani*	—	—	—	12	—	25	—	7	—	—	—	4	—	—	—	48
3. *D. bipectinata*	—	5	—	22	—	15	18	—	8	—	10	1	—	14	—	93
4. *D. eugracilis*	4	—	10	—	2	—	—	4	—	—	—	—	—	—	—	20
5. *D. giriensis*	—	—	—	2	—	8	—	5	—	—	—	—	—	—	—	15
6. *D. jambulina*	—	5	8	—	4	3	—	6	—	—	7	—	—	—	—	33
7. *D. mysorensis*	—	—	—	—	—	—	3	—	—	—	—	2	—	—	—	5
8. *D. malerkotliana*	46	82	35	48	45	—	37	25	34	88	—	60	32	28	20	580
9. *D. pseudoananassae*	—	2	—	6	—	3	—	—	4	—	—	—	—	—	—	15
10. *D. punjabiensis*	—	2	—	1	—	—	4	—	—	—	—	—	—	—	—	7
11. *D. nagarholensis*	1	4	—	10	—	7	—	9	—	—	—	14	—	—	4	49
12. *D. suzukii*	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
13. *D. takahashii*	32	40	45	—	36	—	52	—	—	37	22	11	—	35	6	316
14. *D. cauverii**	—	—	—	1	4	—	11	—	—	10	—	—	—	—	—	26
15. *D. sampajensis**	4	—	—	10	—	14	—	1	—	—	3	—	—	—	—	32
16. *D. madikerii**	—	—	—	—	—	—	4	6	—	10	—	14	—	—	10	44
17. *D. gangothrii**	—	—	—	—	2	—	—	—	9	—	3	—	7	—	—	21
18. *D. nasuta*	31	20	40	35	38	5	33	42	30	42	31	17	28	35	39	466
19. *D. neonasuta*	—	—	—	—	—	—	1	—	—	—	4	—	—	—	—	5
20. *D. immigrans*	10	20	40	30	35	28	25	22	34	32	38	25	34	32	48	453
21. *D. nigra*	—	—	—	6	—	—	—	10	14	7	16	23	—	4	12	92
22. *D. meijeri indicus*	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	2
23. *D. mundagensis*	—	—	—	—	—	—	—	—	6	—	—	—	4	—	—	10
24. *D. captomyza*	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
Total number of individuals	128	186	178	183	167	108	188	137	139	228	135	171	105	148	139	2340
Total number of species	7	10	6	12	9	9	10	11	8	8	10	10	5	6	7	

* New species.

gation made in the vast unexplored area of Sampaje ghats (Western ghats) throws some light not only on the pattern of distribution but also on their dependance on the tropical rain forests. For instance the 15 sites with variable altitudes having more or less similar habitats reveal considerable differences in the species composition as well as in the relative abundance of different species. This may be partly ascribed to the differences in the altitudes and partly to the unknown micro-environmental factors in which the sites differ as well as to the intrinsic abilities of the species to colonize.

Analysis of the *Drosophila* sample reveals that even though many species could be collected, only 4 species, *D. immigrans, D. nasuta D. malerkotliana* and *D. takahashii* were found to be present in almost all the sites in considerable numbers, indicating their ecological dominance over other species. Further, other species such as *D. pseudoananassae, D. jambulina, D. mysorensis, D. bipectinata, D. nigra, D. mejeri indicus* which were reported occassionally in the plains (Reddy and Krishnamurthy 1974) were found to occur more or less frequently in the tropical rain forests indicating the availability of favourable breeding sites for their colonization. In addition several species such as *D. anomelani, D. eugracilis, D. giriensis, D. punjabiensis, D. nagarholensis, D. suzukii* and *D. mundagensis,* which were not reported from the orchards and gardens of the peninsular India occurred in the tropical rain forests indicating the dependence of these species on the forest type of vegetation. *D. ananassae,* a common domestic species on the plains were found absent in almost all the sites except a few individuals at one site indicating its lack of competence to colonize in the tropical rain forests.

Another interesting feature in the *Drosophila* fauna of the tropical rain forests of Sampaje ghats is the finding of four new species *D. sampajensis, D. cauverii, D. madikerii* and *D. gangothrii* which have been described by us (1980, in press). In view of this, the *Drosophila* fauna of Sampaje ghats is of special interest and value as it offers a rich variety of species.

The most noteworthy feature of the *Drosophila* fauna of Sampaje ghats is in its dominance of the members of the *melanogaster* and *immigrans* species groups belonging to 2 sub-genera, *Sophophora* and *Drosophila* respectively. Such sympatric association and ecological dominance of the members of 2 species groups in the area under investigation is in confirmity with the findings of Reddy and Krishnamurthy (1974, 1977), Prakash and Reddy (1978) and also with the suggestion of Bock and Wheeler (1972). Incidentally the finding of 4 new species belonging to the *melanogaster* species group from this area corroborates with the suggestion of Bock and Wheeler (1972) who regarded the Indian sub-continent as the general area for the origin and wide speciation of *melanogaster* species group.

The diversity in the species composition as well as the finding of four new species in the area under study indicate that the *Drosophila* fauna of Sampaje ghats is exceedingly more complex than that of other habitats in the plains of peninsular India. In view of this it is felt that the Sampaje ghats with its luxuriant flora offer a variety of natural environs for colonization by the members of the genus, *Drosophila.*

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29. POLYMORPHISM IN *CALLOSOBRUCHUS CHINENSIS* (LINN.) (COLEOPTERA: BRUCHIDAE)

INTRODUCTION

Callosobruchus chinensis (Linnaeus) is a well known pest of stored grams and other edible legumes and is widely spread in Asia and Africa. Much work has been carried out on its general biology in this laboratory (Arora & Singh 1970) and elsewhere (Howe and Currie 1964, Seddiqi 1972). During the course of our observations, we have come across three different types of females which appear in the laboratory cultures of this species in different parts of the year. Two distinct forms have earlier been recorded in the allied species, *Callosobruchus maculatus* (Fabricius), which show differences not only in the colour pattern of the body but also in their fertility, activity and other characteristics (Southgate *et al.* 1957, Arora and Pajni 1959, Caswell 1960, Sano 1967, Utida 1954, 1972, 1976). Even the genitalia of these two forms have been found to show structural variations (Arora *et al.* 1967, Spirina 1974). In the background of the recorded dimorphism in *C. maculatus*, the three different forms of *C. chinensis* were studied for their fertility as well as for the time of their appearance in different months of the year. The collected information is being reported for the first time in the present communication. The laboratory cultures of the pest have been maintained on the seeds of *Vigna radiata* Wilcz.

Earlier, Nakamura (1966, 1969) indicated the presence of two forms in *C. chinensis* in Japan, one of which is more active and less fecund than the other but did not mention any morphological differences in the two forms. Likewise, Applebaum *et al.* (1968) compared an Israeli strain of this species with a strain from Japan and noted appreciable differences in their antennae and the arrangement of setae on the prothorax and pygidium but did not comment on their relative fecundity. Fujii (1968), on the other hand, compared the biological characteristics of four strains of *C. chinensis* procured from different localities of Japan and Iran, but did not find much difference in the fecundity, fertility and the longevity of their adults.

OBSERVATIONS AND DISCUSSION

Detailed observations made between August, 1983 and February, 1985 have revealed the presence of three different forms of females in the laboratory cultures of *C. chinensis.* These can be made out from one another on the basis of the pattern of setae on their pygidia. One of the forms, which is available throughout the year, shows a median stripe of white setae on the pygidium, with the rest of its surface covered uniformly with brownish setae. Another common form has the surface of the pygidium almost uniformly covered with white setae. The third form also has a stripe of white setae in the middle of pygidium, but the central portions of the lateral areas of the pygidium are completely bare to expose the black ground colour while their surrounding surface is beset with brownish setae. For the sake of brevity, these forms have been designated as 'brown pygidium', 'white pygidium', and 'black pygidium' females respectively.

A monthwise random sampling from the laboratory cultures has shown that the 'brown pygidium' females are available throughout the year, although their number fluctuates a good deal and the variation appears to be related to the appearance of other two forms during

different months. The 'white pygidium' females, on the other hand, first appear with the warming of atmosphere in the month of March and increase in number through the summer months to reach a population peak during August-September. Thereafter it falls through October-November to disappear in the Second half of November. The 'black pygidium' form is noticed in the winter months of October to February. The highest population of this form is noted during November-December, after which the population gradually declines and the form disappears in March.

As far as the fecundity of the three types of females is concerned, it is seen from Table 1 that the 'brown pygidium' female shows more or less normal fecundity and the monthwise variations is according to the general pattern in the normal females of bruchids in general. Just like other bruchid species and infact other stored grain pests, the fecundity is the highest during the most favourable conditions of hot and wet months of July to September and is relatively low during the extreme hot and cold months. However, the fecundity of the 'white pygidium' females is comparatively much lower from that of brown pygidium' females during all the eight months of their coexistence. On the other hand, the number of eggs laid by the females with 'black pygidium' is in the same range as that of the 'brown pygidium' females but the fecundity of the former is definitely more than the latter during the months when they exist together.

It is evident from the foregoing account that a 'white pygidium' female with reduced fecundity appears due with a rise in temperature during the hot parts of the year as has also been reported in *C. maculatus* (Caswell 1960, Sano 1967, Utida, 1972). Likewise, the 'black pygidium' female is presumably the result of fall in temperature during the winter months which appears to be a unique feature of this species as no such form has been described in any species of bruchid so far. It is also observed that the 'white pygidium' female neither visits the fields for oviposition like the 'active' and 'white pygidium' female of the Japanese and African populations of *C. maculatus* (Utida 1972, Caswell 1960), nor does it be-

TABLE 1

SHOWING THE INCIDENCE AND FECUNDITY OF THE THREE TYPES OF FEMALES OF *Callosobruchus chinensis* (LINN.) DURING DIFFERENT MONTHS

Month	Brown pygidium Females %age incidence	Brown pygidium Females Fecundity	White pygidium Females %age incidence	White pygidium Females Fecundity	Black pygidium Females %age incidence	Black pygidium Females Fecundity
March, 84	81.4	60.7±5.33	18.6	48.3±4.80	—	—
April, 84	80.9	61.7±6.14	19.1	47.7±6.70	—	—
May, 84	79.6	37.6±5.39	20.4	30.8±4.39	—	—
June, 84	61.7	50.3±5.55	38.3	41.6±3.86	—	—
July, 84	56.0	69.4±6.60	44.0	58.7±4.66	—	—
August, 84	30.2	78.6±7.12	69.8	61.8±4.88	—	—
Sep., 84	32.7	69.1±3.50	67.3	51.0±4.75	—	—
Oct., 84	41.7	63.6±6.46	20.8	46.0±6.03	37.5	74.05±8.28
Nov., 84	47.9	53.3±7.19	—	—	52.1	60.3 ±6.70
Dec., 84	53.0	54.0±4.83	—	—	47.0	65.5±10.39
Jan., 85	60.9	52.1±6.38	—	—	39.1	58.1 ±5.76
Feb., 85	57.5	53.7±5.92	—	—	42.5	55.9 ±6.74

come totally sterile like the similar female of Indian strain of that species (Arora & Pajni 1959, 1967; Pajni *et al.* 1984). The exact significance of the cyclical appearance of the three forms of *C. chinensis* in the course of the year is not properly understood but it is likely that the phenomenon regulates the increase or decrease of the pest population through a self regulating system leading to the appearance of variably fecund females under the stimulus of different climatic conditions. Further studies and experimentation for establishing the true causes of the appearance of polymorphic females are underway.

It may also be stated here that some odd looking forms with colour patterns different from the normal individuals and with impaired fecundity have also been recently observed in the laboratory cultures of *C. analis* (Fabricius) and *Zabrotes subfasciatus* (Boheman). Dimorphism or even polymorphism, therefore, seems to be quite prevalent in Bruchidae.

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30. OCCURRENCE AND LIFE HISTORY OF *CASSIDA CIRCUMDATA* HERBST (COLEOPTERA: CHRYSOMELIDAE) IN KEOLADEO NATIONAL PARK, BHARATPUR, INDIA

(*With four text-figures*)

Cassida circumdata damages the leaves of *Ipomoea reptans* in Keoladeo National Park, Bharatpur. Their grubs feed on chlorophyll from the underside of the leaves and skeletonize them completely which then dry up. The adults of *C. circumdata* are small and of yellowish green colour. The eggs are faintly brownish and the eggs hatched within 3 to 4 days. The grubs have a peculiar habit of carrying their excreta at the tail end. The larval stage lasted for 11 to 18 days under laboratory conditions. Pupation takes place on the leaves and the pupal stage lasted for 5 to 8 days. The life cycle from egg to adult took 21 days. The maximum size of egg, larva, pupa and adult were recorded.

INTRODUCTION

Though the species of Chrysomelidae are among the commonest insects, perusal of literature of Chrysomelidae in India shows they are poorly known taxonomically and ecologically (Jacoby 1908, Maulik 1919, 1926, 1936). There is no comprehensive systematic and life history study of the species of chrysomelidae except that of Trehom and Bagal (1957), Pajni and Bansal (1977), Pajni and Singla (1981), Barrows (1979), Katiyar and Gargav (1975), Visalakshi *et al.* (1980) and John George and Venkataraman (1986). The present study reports the occurrence and life history of the tortoise beetle *Cassida circumdata* Herbst, a polymorphic species parasitic on *Ipomoea reptans* (Linn.) an aquatic weed forming a dominant aquatic vegetation of the Keoladeo National Park at Bharatpur (27° 7.6′ to 27° 12.2′ N and 77° 29.5′ to 77° 33.9′ E).

MATERIAL AND METHODS

Cultures of acclimatized *C. circumdata* were kept at a temperature of 28 ± 2°C and relative humidity of approximately 50-70% under laboratory conditions. The room where the experiment was conducted had two eastfacing windows and was not illuminated with electric light during the day and night.

Newly hatched larvae were kept one each in fifteen cylindrical transparent plastic containers 95 mm height and 75 mm diameter for life history studies. The screw tops had

holes for ventilation. Discs of filter paper were placed at the bottom of the containers to absorb excess moisture and facilitate cleaning. Fresh, clean and young leaves of *I. reptans* were supplied to the larvae daily. The body length and width were measured everyday using an ordinary compound microscope with calibrated ocular micrometer. The egg, larval stages, pupa and adult were drawn using camera lucida.

Results and Discussion

Cassida circumdata Herbst, 1979
(Figure 1).

Synonym: *Metriona circumdata* Spaeth, 1903, p. 128; Maulik, 1913, p. 114.

Egg: The eggs of *C. circumdata* measure 1.071 ± 0.041 mm in length and 0.453 ± 0.045 mm in width. Egg oval, covered with a white papery substance (Fig. 1). One egg is laid in each case and most of the eggs were laid singly; very rarely they laid eggs in clusters of two to three. The incubation period of *C. circumdata* is 4 days. In *Aspidomorpha furcata* it is 3-4 days (Visalakshi *et al.* 1980), while in *Gratiana lutescens* it is 6 days (Siebert 1975), in *Metriona bicolor* 5 to 8 days and in *Deloyala guttata* 2 to 7 days (Barrows 1979).

Larva: The first instar grub is yellowish but becomes green soon after it starts feeding. The body of the larva is flat and has spines around the periphery with two long caudal spines. It is 1.042 ± 0.249 mm in length and 0.631 ± 0.160 mm in width. The larvae feed on the green matter from ventral surface of leaves. In the present study maximum number of 1st instar larvae moulted on the 3rd day and the moulted skin remained attached to the anal process (Fig. 1). The 2nd, 3rd, 4th, and 5th instars measure 1.752 ± 0.169 mm, 2.336 ± 0.304 mm, 3.482 ± 0.622 mm and 4.810 ± 0.558 mm in length and 0.888 ± 0.094 mm, 1.177 ± 0.120 mm, 1.773 ± 0.371 mm and 2.522 ± 0.371 mm in width respectively. The

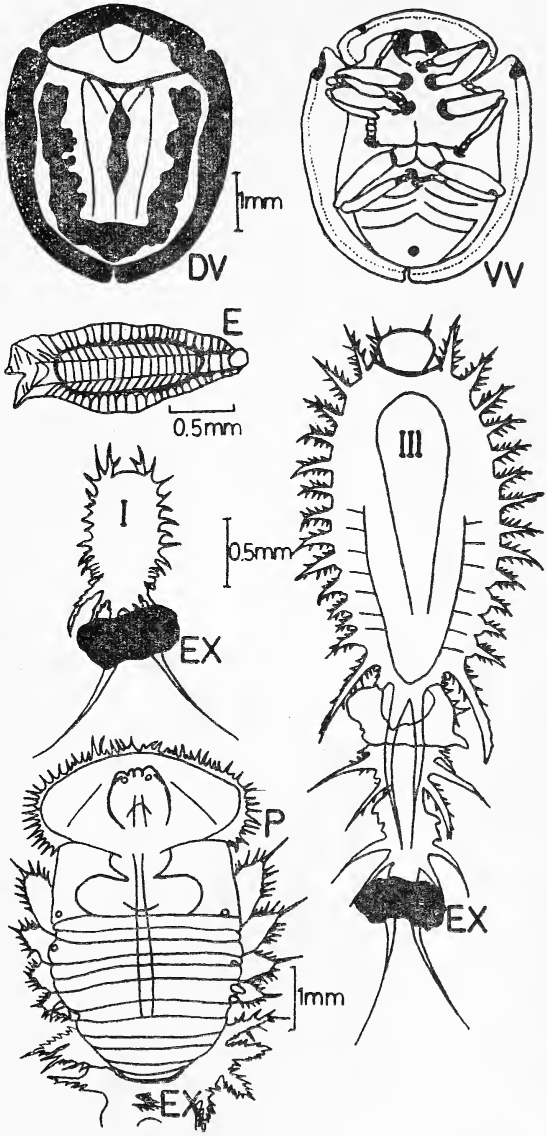

Fig. 1. Larval stages of *C. circumdata*: DV — Dorsal View; VV — Ventral View; E — Egg; EX — Exuvia; P — Pupa; I and III — larval instars.

duration of the different instars is 2, 2, 2 and 2-4 days respectively (Fig. 2). Except for the size and the accumulation of exuvial and other fecal debris on the caudal spines, there is very little difference in appearance among the instars.

Pupa: Under normal conditions the pupa does not differ greatly in appearance from the larva. It has similar pale green colour which blends well with the foliage of *Ipomoea reptans.* The larva has branched spines around the anterior part of the body, whereas the smooth shield forming the thoracic segments in the pupa bears many broad — based slender straight spines. The abdominal segments bear broad-based almost triangular groups of fused spines projecting outwards from the periphery. The pupa measures 4.84 ± 0.252 mm in length and 2.86 ± 0.211 mm in width. The mounted skins are held dorsally on the pupa. The adult comes out after a pupal period of 3 to 5 days.

In the present study the larval and pupal period of *C. circumdata* varied from 11 to 18 days and 5 to 8 days respectively. In other species like *Aspidomorpha miliaris* (Katiyar and Gargav 1975) and *Aspidomorpha furcata* (Visalakshi *et al.* 1980) the larval period varied from 29-35, and 10-11 days and the pupal period varied from 7-11, and 7 days respectively. In *Deloyala guttata* and *Metriona bicolor* (Barrows 1979) the larval stage lasted for 18-23 days and 21-25 days and the pupal stage lasted for 3-9 days and 6-9 days respectively.

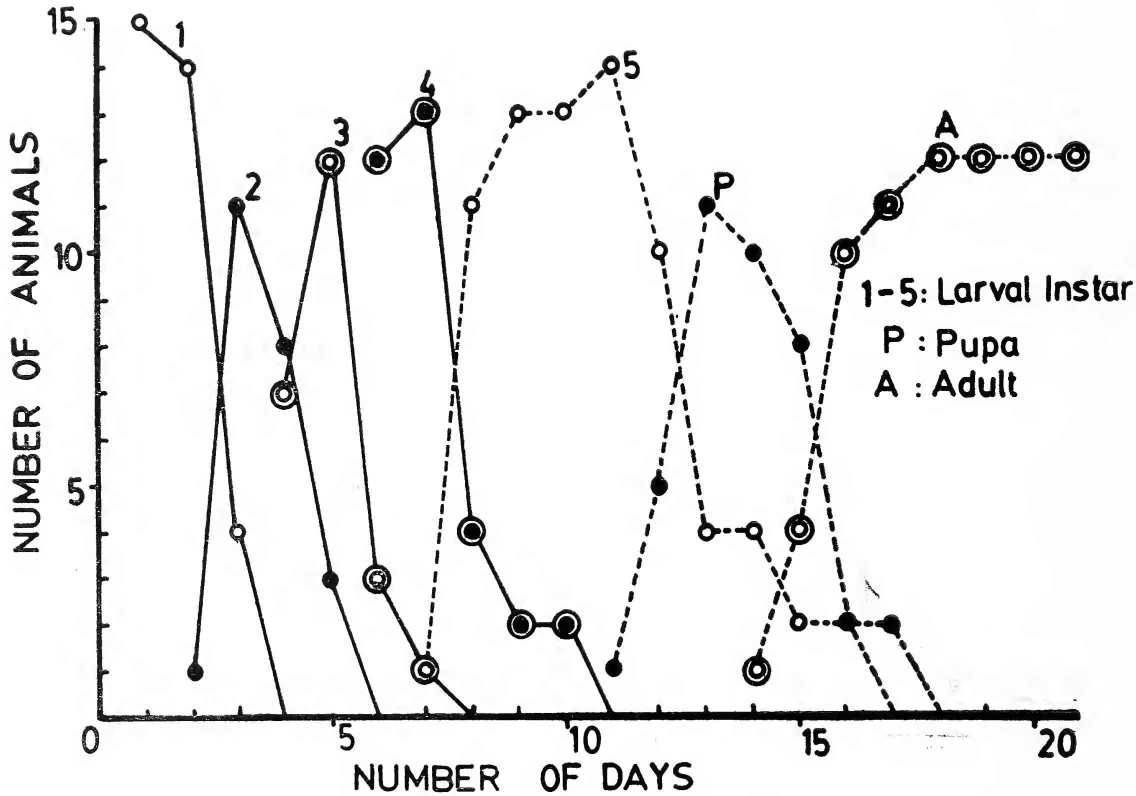

Fig. 2. Longevity of larvae, pupa and adult.

The total number of days taken from egg to adult for *C. circumdata* was 21 days. However, the number of days varies for different species under different environmental conditions (Lefroy and Howlett 1909, Katiyar and Gargav 1975, Barrows 1979).

Adult: Shortly after emergence, the adult is pale green. Males are usually smaller than the females. Laboratory reared females were 5.135 $\pm$ 0.182 mm in length and 4.224 $\pm$ 0.159 mm in width, whereas males were of 4.631 $\pm$ 0.50 mm in length and 3.912 $\pm$ 0.246 mm in width. In both the male and female along the middle of each elytron a broad black stripe joins the other forming a 'U' shaped marking posteriorly at the suture. The newly emerged adult rests for a while. They do not feed on the leaves entirely and do not even skeletonize them to the same extent as larvae do.

The mating which began after 7-10 days of emergence occurred on almost all days. Out of the twenty two pairs (male and female) that were collected and kept in separate containers, only nine pairs survived for 30 days. *Aspidomorpha miliaris* did not lay eggs in captivity (Katiyar and Gargav 1975). Adult *C. circumdata* mated and laid eggs daily in captivity. A single pair of *C. circumdata* which survived for 30 days under captivity laid 368 eggs. The maximum number of eggs laid by a single adult female in captivity within 24 hours was 36.

Longevity: The longevity of the *C. circumdata* from egg to adult was measured under laboratory conditions. Around 18th day all of the pupae became adult and adults survived only upto the 25th day (Fig. 3). *A. miliaris* (Katiyar and Gargav 1975) and *A. furcata* (Visalakshi *et al.* 1980) took 29-35, and 10-11 days for larval, 7-11, and 7 days for pupal periods respectively. The larval stage of *C. circumdata* lasted for 11 to 18 days and pupal period for 5 to 8 days respectively. However, for adults it varies. In the present study the adults lived only for 7-8 days in captivity. The adult *A. miliaris* (Katiyar and Gargav 1975) continued to survive for more than 25 days in captivity. Adult *M. bicolor* and *D. guttata* (Barrows 1979) lived for 111 and 105 days respectively. Another study made later on *C. circumdata* shows that the adults emerged in captivity lived upto 80 days under diffe-

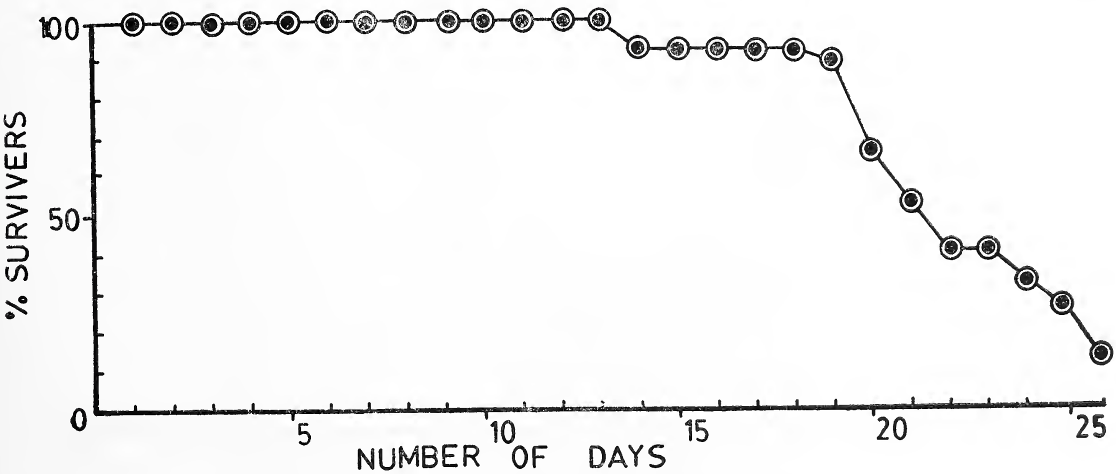

Fig. 3. Survival curve of *C. circumdata* cultured under laboratory conditions (28°-30°C).

rent conditions. From this it is apparent that the longevity of larvae, pupae and adult varies at different conditions.

Growth: The mean body length and width (Breadth) of each day are shown in Figure 4. The maximum growth rate in the body length (0.962 mm) occurred between the 5th and 6th day. The rate of growth is fastest in the larval stages, as it is true with other members of family Chrysomelidae. The body width also grows along with body length and it reaches more than 2/3 of the body length when the larvae become adult. The pattern is almost same in *Aspidomorpha furcata* (Visalakshi *et al.* 1980), *Deloyala guttata* and *Metriona bicolor* (Barrows 1979) and *Cassida varians* (Maulik 1919).

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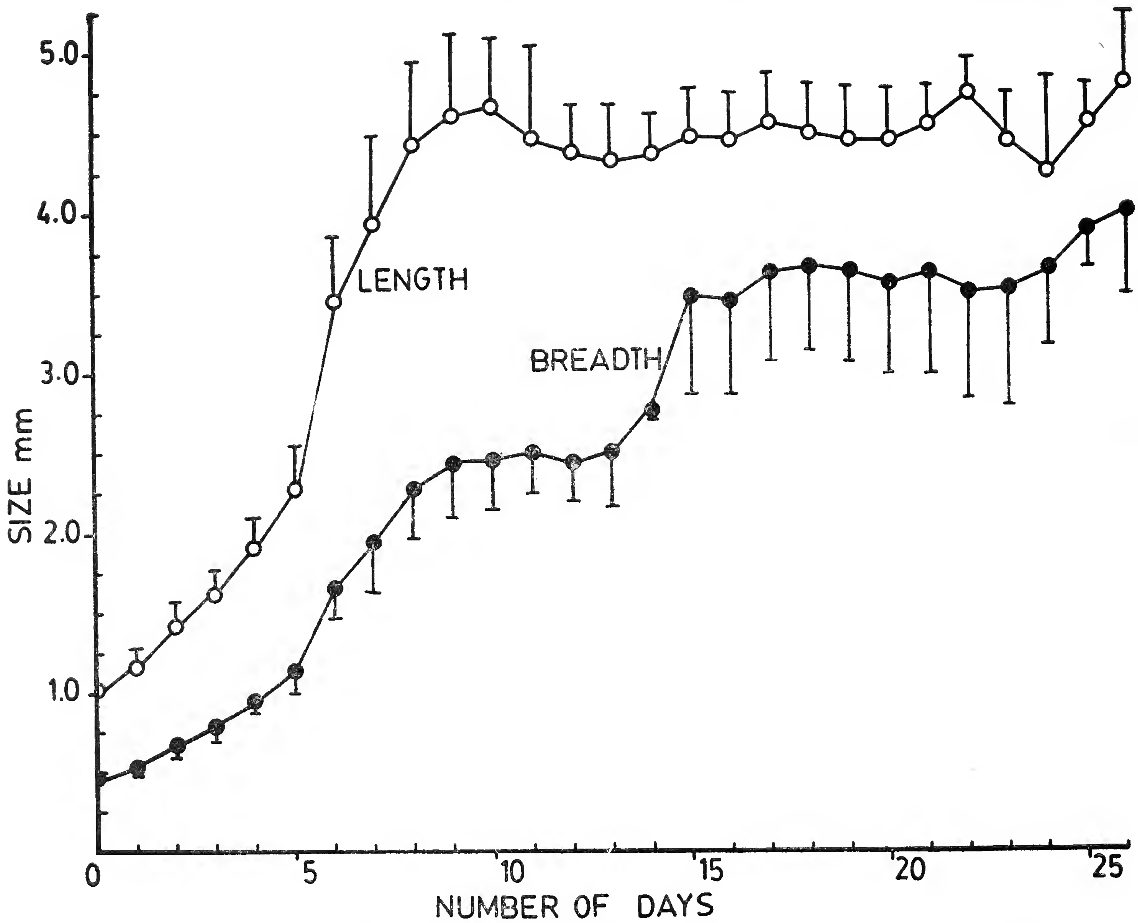

Fig. 4. Relationship between the mean body length, breadth and number of days.

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31. A NOTE ON THE FOOD OF THE SPIDER *ARGIOPE ARCUATA* SIMON (FAMILY: ARANEIDAE)

On 24th November 1985 when I was walking on a bird survey from Fatehpur to Hanuman Jhora at Karera Bustard Sanctuary, Madhya Pradesh I noticed the spider *Argiope arcuata* in its web with two butterflies of *Acraea violae* Fabr. (Family Nymphalidae) entangled on it. In addition I saw 23 butterflies of the same species underneath the spider web. As soon as the spider completed sucking the sap of the butterfly it cleared the butterfly from its

web and dropped it on the ground. The butterfly was abundant in the month of November. On 3rd December 1985 I again visited the same area and cleared the area underneath the spider web in order to count the daily trapped butterflies. But due to area clearance butterflies were not entangled on the web.

ACKNOWLEDGEMENT

I thank to Dr. Animesh Bal, Zoologist, Zoological survey of India, Calcutta for the identification of the spider specimen.

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32. NEW DISTRIBUTIONAL RECORDS OF DICOTS FOR PUNJAB STATE (INDIA)

I have been engaged in the study of the flora of Punjab State eversince July 1963. Consequently, detailed distributional and ecological accounts along with the lists of sedges (Sharma 1979, 1980), grasses (Sharma 1983 a, b) and the rest of the monocots (Sharma 1985) have been published. The study of the dicotyledonous plants collected by me during the last 22 years from Punjab shows that 16 species recorded here have not been reported earlier from this area. It may not be out of place to mention that these have not been recorded even by Nair (1978) in his comprehensive and the latest floristic work dealing with Punjab. He has accounted for 1064 taxa of spermatophytes and has taken into account all the previous publications pertaining to the flora of Punjab as well as the pertinent exsiccata conserved in the herbaria of Forest Research Institute, Dehra Dun (DD) and Botanical Survey of India, Dehra Dun (BSD).

Listed below are 16 species of dicots distributed among as many genera and 13 families. But for the minor modifications to conform to the present day circumscription and delineation, the arrangement of the families here is the same as in Hooker (1872-1888). Disposition of genera, however, is alphabetical under the pertinent family. All specimens cited presently are housed in Herbarium Punjabi University, Patiala (PUN).

CRUCIFERAE

Capsella bursa-pastoris (Linn.) Medik.

Occasionally found in cultivated fields.

Fl. & Fr.: January-April.

Specimens examined: Ropar, M. Sharma 8992.

VIOLACEAE

Viola cinerea Boiss. var. **stocksii** (Boiss.) Beck.

Some plants were gathered from rocky slopes of the hill. This taxon was treated under *V. cinerea* by Hook. f. & Thoms. (in Hook. f. 1872). However *V. cinerea* is a slaty white perennial, whereas the present taxon is a glabrescent annual.

Fl. & Fr.: February-April.

Specimens examined: Ropar Shivaliks, M. Sharma 10493.

STERCULIACEAE

Waltheria indica Linn.

Very rare, only one plant seen.

Fl. & *Fr.*: August-December.

Specimens examined: Ropar, M. Sharma, 10441.

RHAMNACEAE

Helinus lanceolatus Wall. ex Brand.

Locally common in Shivaliks.

Fl. & *Fr.*: November-May.

Specimens examined: Nangal, M. Sharma 8961.

Ziziphus oxyphylla Edgew.

Rare, on a hill slope.

Fl.: May-June.

Specimens examined: Nangal Shivaliks, M. Sharma 8991.

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven subsp. **sessiliflora** (Mich.) Raven

Occasionally found along water courses in the foot-hill zone of the State.

Fl. & *Fr.*: March-November.

Specimens examined: Chamkaur Sahib, M. Sharma 10407.

CUCURBITACEAE

Luffa acutangula (Linn.) Roxb. var. **amara** (Roxb.) Cl.

On roadside bushes and hedges in the drier parts of the State.

Fl. & *Fr.*: August-October.

Specimens examined: Jhunir, M. Sharma 11721.

AIZOACEAE

Mollugo stricta Linn.

Locally common in fallow fields, along the edges of cultivated fields or irrigation channels. In Indian taxonomic literature, this taxon has often been treated as conspecific with *M. pentaphylla* Linn. According to Sivarajan & Usha (1983) these two Linnaean species are distinct.

Fl. & *Fr.*: August-October.

Specimens examined: Rajpura, Sirhind, Sanour, Patiala, Chamkaur Sahib; M. Sharma 1412, 1527, 1558, 1605, 10322.

CONVOLVULACEAE

Ipomoea sindica Stapf.

Common in the semi arid areas of the State in cultivated sandy fields and among hedges.

Fl. & *Fr.*: August-November.

Specimens examined: Mansa, M. Sharma 11441.

SCROPHULARIACEAE

Bacopa procumbens (Mill.) Greenm.

A native of tropical America. It is found on moist ground.

Fl. & *Fr.*: March-May.

Specimens examined: Ropar, Nangal; M. Sharma 10508, 10557.

Lindernia multiflora (Roxb.) Mukerjee

Plentiful in rice-fields along Chamkaur Sahib-Bela Road.

Fl. & *Fr.*: August-October.

Specimens examined: Bela, Chamkaur Sahib; M. Sharma 10460, 10483.

Veronica persica Poir.

Rare, some plants gathered from the foothills.

Fl. & *Fr.*: March-May.

Specimens examined: Nangal, M. Sharma 9185.

ACANTHACEAE

Justicia diffusa Willd.
Rare, in a 'cho'-bed.
Fl. & Fr.: August-November.
Specimens examined: Anandpur Sahib, M. Sharma 10446.

LABIATAE

Scutellaria repens Buch.-Ham. ex D. Don
Common near Bhakra Dam site.
Fl. & Fr.: August-November.
Specimens examined: Bhakra Dam, Nangal Shivaliks; M. Sharma 3229, 8962.

POLYGONACEAE

Rumex hastatus D. Don
Very common at Nangal along the banks of river Sutlej.
Fl. & Fr.: October-March.
Specimens examined: Nangal, M. Sharma 8963.

MORACEAE

Ficus hederacea Roxb.
Rare.
Receptacles: Appear in March but mature in August-September.
Specimens examined: Faridkot, M. Sharma 11742.

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I am grateful to the Heads of Botany departments of Punjab, Punjabi and Punjab Agricultural Universities for assistance in various ways. Herbarium and library facilities provided by the concerned authorities of some Indian Herbaria (DD, BSD, LWG, CAL) are thankfully acknowledged. I am also obliged to UGC New Delhi for providing travel grants to visit these herbaria.

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33. *CALDESIA PARNASSIIFOLIA* (LINN.) PERL. (ALISMATACEAE) — A NEW RECORD FOR WESTERN HIMALAYA

During an extensive plant collection in Almora district of Kumaun region, the senior author collected an interesting aquatic herb *Caldesia parnassiifolia* (Linn.) Perl., which is now being reported for the first time from Western Himalaya. The specimens are lodged in the Herbarium, Department of Botany, Kumaun University Campus, Almora.

Caldesia parnassiifolia (Linn.) Perl., Fl. Ilal. 3: 599, 1853; Hartog in Steenis, Fl. Malesiana Ser. 1, 5: 319, 1957 (*parnassiifolia*); Subramanyam, Aquatic Angiosperms. 84, fig. 51, 1962; Saldanha and Nicolson, Fl. Hassan Dist. 631, fig. 105, 1976. *Alisma parnassiifolia* Bassi ex L., Syst. Nat. ed. 12, 3 (App.): 230, 1768. *A. reniforme* D. Don, Prodr. Fl. Nepal 22, 1825; Hooker, Fl. Brit. Ind. 6: 560, 1893; Gamble, Fl. Madras 1594 (1112), 1931. *Caldesia reniformis* (D. Don) Makino, Bot. Mag. (Tokyo) 20: 34, 1906.

A glabrous aquatic herb. Leaves floating deeply cordate, subcoriaceous, 13-15 veined, posterior lobes round. Flowers white, in panicle; branches of panicle in whorls of three. Stamens 6, filaments broadened at base. Pistils 5-8, crowded on a small receptacles; style subterminal, persistent. Achenes awned, elliptic, with 3-5 smooth longitudinal ribs on the dorsal side.

Specimen examined: Kumaun Himalaya, District Almora, Baijnath (1400 m), P. C. Pande 4004.

Ecology: Scarce, in ponds, tanks and shallow water bodies along river bank at Baijnath near Garur, and commonly associated with *Nelumbo nucifera, Utricularia stellaris, Monochoria vaginalis* and *Blyxa auberti* etc.

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34. NOTES ON CYPERACEAE OF MAHARASHTRA

During our studies on the Cyperaceae of Maharashtra we have come across some interesting data regarding the distribution and identify of some species which require corrections and additions to the existing literature.

1. **Cyperus castaneus** Willd. Sp. Pl. 1: 278, 1797; Clarke, in Hook. f., Fl. Brit. Ind. 6: 598, 1893, Cooke, Fl. Bombay Pres. 2: 861 (2: 374), 1909; Blatter & McCann, Journ. Bombay nat. Hist. Soc. 37(2): 258, 1934.

This species has been reported from Konkan by T. Cooke (1909) and by Blatter & McCann from Konkan, Bombay and Laddapur (1934)

on the authority of T. Cooke. Vartak and Ghate (1983) have not included this species in their enumeration of sedges from Western Maharashtra, thereby indicating that it is not represented in Poona herbaria (BSI, MACS). There is no specimen of this species in Blatter Herbarium too. We have collected it from Aronda-Savantwadi.

Exsiccata: S. M. Almeida — 1904; M. R. Almeida — 51 (ALC).

2. **Fimbristylis cinnamometorum** (Vahl) Kunth. Enum. 2: 229, 1837; Kern, in Fl. Males. Ser. 1, 7 (3): 565, 1974. *Scirpus cinnamometorum* Vahl, Enum. Pl. 2: 278, 1908. *F. cyperoides* Br. var. *cinnamometorum* C. B. Clarke, in Hook. f., Fl. Brit. Ind. 6: 650, 1893 & Ill. Cyper. t. 44, f. 1-4, 1909.

This species is not reported from Maharashtra earlier. We have collected it from Savantwadi.

Exsiccata: S. M. Almeida — 2843.

3. **Fimbristylis kingii** C. B. Clarke ex Boek., Cyper. Nov. 2: 1890; Clarke in Hook. f., Fl. Brit Ind. 6: 633, 1893.

This species is not reported from Maharashtra as well as from erstwhile Bombay Presidency. We have collected it from Maharashtra, from Savantwadi taluka. In Blatter herbarium (BLAT), there are specimens from Nilgiris. (Fyson-2706; Gamble-397, 16695).

Exsiccata: S. M. Almeida — 3637, 3732.

4. **Fimbristylis polytrichoides** (Retz.) R. Br., Prodr. 226, 1810, Clarke in Hook. f., Fl. Brit. Ind. 6: 632, 1893 & Ill. Cyper. t. 40, ff. 8-9, 1909; Kern, Fl. Males. Ser. 1, 7 (3); 586, 1974. *Scirpus polytrichoides* Retz. Obs. Bot. 4: 11, 1786.

There are a number of specimens of this species in Blatter Herbarium collected from Madh-Island, near Bombay, along with specimens from other localities. All the Madh-Island specimens, however, differ from the rest of the material and the description of the species in literature, in having brown coloured nuts (not yellow) and glumes exceedingly longer than so far described.

Exsiccata: SMA — 2421, 2951.

5. **Fimbristylis siberiana** Kunth, Enum. Pl. 2: 237, 1837; Kern, in Blumea 8(1): 131, 1965; Naithani & Raizada in Ind. For. 103: 416, 1977. *F. ferruginea* (non Vahl, 1806); Decne, Nouv. Ann. Mus. Hist. Nat. Paris 3: 352, 1834. *F. ferruginea* Vahl var. *siberiana* Boek. in Linnaea 37: 17, 1871.

The species probably goes in our local floras under *Fimbristylis ferruginea* Vahl. For description and distinguishing characters see Naithani & Raizada (1977).

In Blatter Herbarium there are specimens from Poona and Malad.

Exsiccata: M. Ezekiel-Poona-30420; G. L. Shan-Malad-4774, 7105 (BLAT).

6. **Fuirena trilobites** C. B. Clarke in Hook. f. Fl. Brit. India 6: 66, 1893; Vartak, Journ. Univ. Poona 40: 196, 1971.

The species has been reported from Gujarat and Bangalore (Karnataka). We have collected it from Savantwadi, in Maharashtra. For description see Vartak (1971).

Exsiccata: S. M. Almeida — 3393, 4223, 3662.

7. **Scleria rugosa** R. Br., Prodr. 240, 1810; Kern in Reinwardtia 6: 76, 1961 & Blumea 11: 206, f. 8, 1961; Govindarajalu in Journ. Bombay nat. Hist. Soc. 69 (1): 246, 1972; Naithani & Raizada in Ind. Forester 103: 411-23, 1977. *S. flaccida* Clarke in Hook. f., Fl. Brit. Ind. 6: 688, 1893 (non Steud., 1855). *S. zeylanica* Clarke in Hook. f., Fl. Brit. Ind. 6: 687, 1893 (non Poir, 1806). *S. annularis* Steud., Syn. Pl. Cyper. 176, 1855 (non Kunth., 1837); Blatter & McCann, Journ. Bombay nat. Hist. Soc. 37 (4): 778-9, 1935.

The species is included here for purpose of correct identity and nomenclature of our material. Vartak and Ghate (1983) reported it from Goa and Thana, under *S. annularis*. In Blatter Herbarium there are specimens from Borivli, near Bombay.

Exsiccata: R. R. Fernandez — 2652, 2665-6.

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35. *OIANTHUS DISCIFLORUS* HOOK. F. — A LITTLE KNOWN TAXON FROM PENINSULAR INDIA

(*With a text-figure*)

During the intensive exploration of the plant wealth of Kurnool district in Andhra Pradesh, a little known taxon was collected and was identified as *Oianthus disciflorus* Hook. f. of the family Asclepiadaceae. The species is very poorly represented in Indian Herbaria. There are only two specimens at MH collected on 31-8-1917 in Ramanapenta in Kurnool district. Perhaps this taxon is endemic to Kurnool district. Although Hook. f. in Flora of British India mentioned that the species occurs in Western peninsula, he was not sure about the area of occurrence and suggested the Konkan. The species is not reported in the Flora of Madras Presidency.

A short description with line diagrams are given to facilitate identification of the plant.

Oianthus disciflorus Hook. f. in Fl. Brit. India 4: 49. 1883. (Fig. 1)

Twining undershrubs, branches glabrous, pubescent when young. Leaves opposite, ovate, ovate-oblong or elliptic-oblong, 3-7 × 1.5-5 cm, acute, glabrous above, minutes pubescent below, entire, base cordate, petioles 1-2.5 cm long, pubescent. Flowers pale violet with pink inside in axillary cymes. Calyx lobes 5, divided nearly to he base, lobes equal, ovate, imbricate, 0.4 × 0.2 cm, sparsely pubescent below, obtuse. Corolla disciform, vertically depressed, 5-lobed purplish pink with in, divided to the mid half, 1 × 0.5 cm, obtuse, corona adnate to the staminal column. Pollinia pendulous, pollinial bags oblong, 1.5 × 0.4 mm, caudicle 1 mm long, corpusculum 0.4 mm long. Ovary globose — oblong, 4 mm long, placenta bifurcate. Follicles not seen.

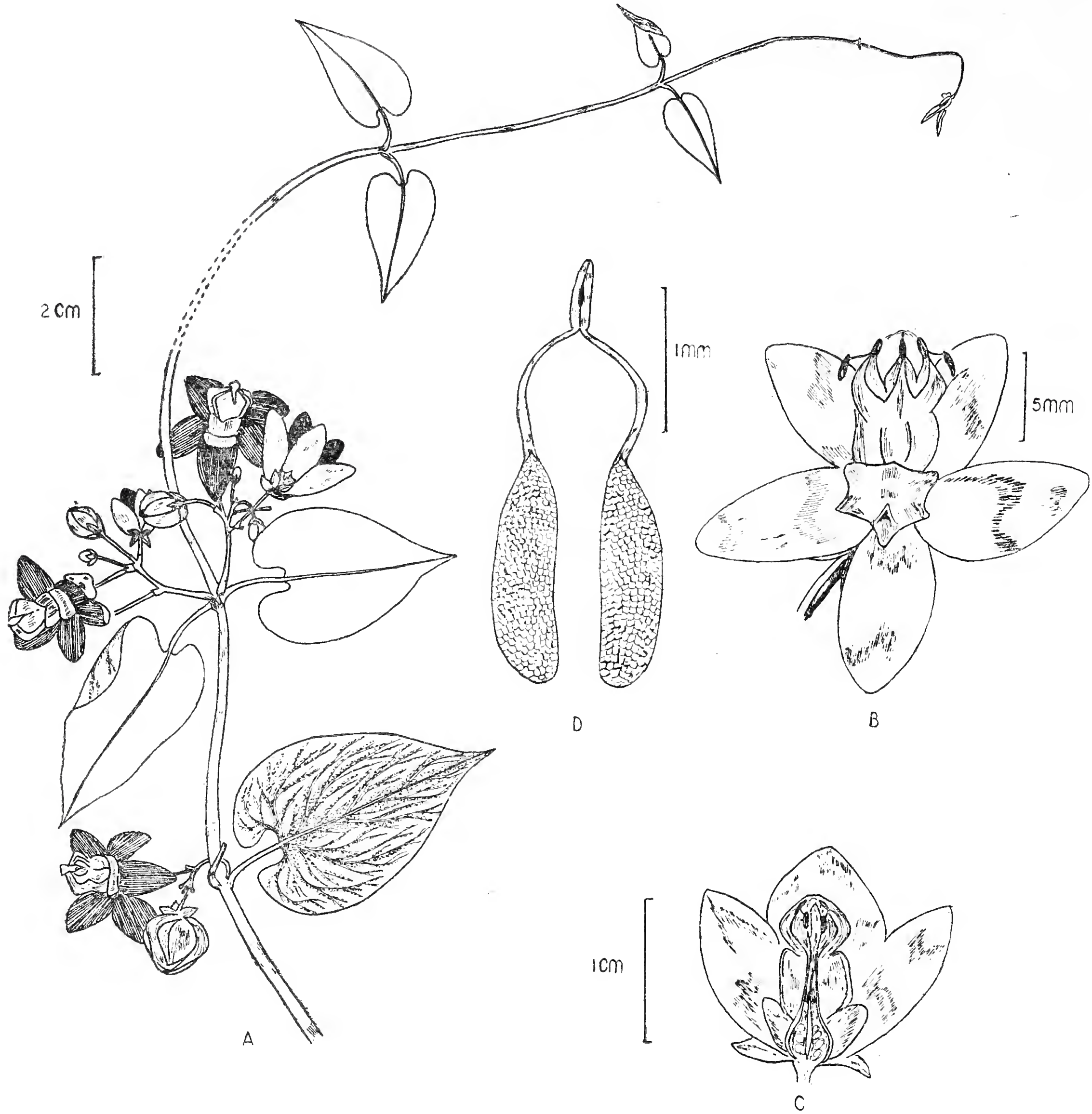

Fig. 1. *Oianthus disciflorus* Hook. f.
A. Twig. B. Flower. C. L.S. of flower. D. Pollinia.

Fl.: July-October.
Distribution: Rare in forests.
Specimens examined: RVR 2522 collected from North Dhone RF on 13-9-1984, housed in SKU and MH.

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36. ON THE IDENTITY AND SYNONYMY OF *HEDYOTIS CONGESTA* R. BR. (RUBIACEAE)

The genus *Metabolos* was postulated by Blume (1826) for reception of a group of species allied to *Hedyotis auricularia* L. which, later on, has been found to be conspecific with *M. venosus* Bl.

Korthals (1851) synonymised all the species of *Metabolos* to *Hedyotis* sect. *Hedyotis.*

Hooker f. (1880) followed Korthals in reducing *Metabolos* species to *Hedyotis* except *M. rugosus* Bl. which he considered as distinct from *Hedyotis* but identical with a Sri Lankan plant described by Thwaites (1859) as *Allaeophania decipiens* Thw.

As all other species of *Metabolos* have been transferred to *Hedyotis,* Hochreutiner (1934) suggested that the name *Metabolos* might be retained for *M. rugosus* Bl. on restricting its generic delimitation. This choice must be regarded as legitimate and therefore the genus *Allaeophania* Thw. becomes superfluous. Bremekamp (1939) proposed a new generic name *Exallage* for accommodating *H. auricularia* and allied species. But Fosberg (1943) and Bakhuizen (1965) rightly did not recognize this genus as distinct for cogent reasons.

Metabolos rigidus Blume (1826) described from Java was characterised by elliptic-oblong leaves acuminate at both ends, flowers in involucrate clustered heads and campanulate calyx. It was transferred to the genus *Hedyotis* L. by Miquel (1857). *H. carnosa* Korth. (1851) was described from Sumatra and Borneo, and was characterised by oblong-ovate, acuminate leaves, laciniate stipules and ovate, acute calyx lobes. In course of taxonomic revision of Indian *Hedyotis,* we have, on the basis of the study of types and other specimens of these taxa observed that the leaves are variable in shape and size, cymes few to many flowered and calyx campanulate or lobes ovate, rounded, obtuse or acute. For these reasons distinctions of these taxa are not tenable. King (1903) while distinguishing *H. congesta* R. Br. *ex* G. Don var. *nicobarica* King from the typical variety by narrowly elliptic-lanceolate leaves tapering at both ends, noted (in Sched.) that his specimen is like *H. carnosa.* On the other hand characters on which King (l.c.) distinguished his var. *nicobarica* are evident on the type specimens of the typical variety. Therefore this variety *nicobarica* also does not stand.

Merrill (Enum. Philipp. Fl. Pl. 3: 500. 1923) reduced *H. leucocarpa* Elm. occurring in Philippine to *H. rigida* (Bl.) Miq. Bakhuizen in Backer & Bakhuizen, Fl. Java 2: 288. 1965, accepted this reduction but treated *H. leucocarpa* Elm. as the correct name since *H. rigida* is already preoccupied. Specimens named as *H. leucocarpa* Elm. in herb. CAL show distinction from *H. rigida* in thinner leaves, long fimbriate calyx lobes and larger fruit. But as the type specimen of *H. leucocarpa* Elm. was not available to us it could not be definitely established if these are taxonomically same or distinct, therefore *H. leucocarpa* is not considered here in the synonymy. Even if it is synonymous *H. congesta* being the earliest valid and effective publication amongst all the names involved, is the correct name, and the synonymy is given as follows.

Hedyotis congesta R. Br. ex G. Don, Gen. Syst. Gard. Bot. 3: 526: 1834 (Type: Penang, 1822, *Wall. Cat.* 844 K-W microfiche CAL!); Hook. f. Fl. Brit. Ind. 3: 61. 1880; King & Gamble in Journ. Asiat. Soc. Beng. 72(2): 161. 1903. *Oldenlandia congesta* (R. Br.) O. Ktze. Rev. Gen. Pl. 1: 2. 1891. *Exallage congesta* (R. Br.) Bremek. in Verh. Kon. Netherl. Akad. Wet. Afd.-Natuurk. ser. 2, 48(2): 142.

1951. *H. argentea* Wall. ex G. Don, Gen. Syst. Gard. Bot. 3: 526. 1834 (Type: Paulo Penang, 1822, *Wall. Cat.* 858 CAL!). *Metabolos rigidus* Bl. Bijdr. 992. 1826 (Type: Java, *Blume s.n.* L!). *H. rigida* (Bl.) Miq. Fl. Ind. Bat. 2: 181. 1857, non (Benth.) Walp. 1851. *H. congesta* R. Br. var *nicobarica* King in Journ. Asiat. Soc. Beng. 72(2): 161. 1903 (Type: Nicobar, 1884, *King* 506 CAL!), SYN. NOV. *H. carnosa* Korthals in Nederl. Kruidk. Arch. 2(2): 161. 1852 (Type: Sumatra, *Korthals s.n.* L!), non Dalz. 1850.

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BOTANICAL SURVEY OF INDIA,
HOWRAH,
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37. A NOTE ON THE *BRACHYSTELMA GLABRUM* HOOK. F. (ASCLEPIADACEAE) FROM SOUTH INDIA

Gamble in his Flora of Presidency of Madras has dealt with six species of the genus *Brachystelma* R. Br. and most of them are restricted to south India. Two new species of the above genus have been described and published by Govindappa Arekal & T. M. Ramakrishna (*B. ciliatum* in *Current Science 50*(3): 145-146. 1981; *B. kolarensis* in the *Proceedings of the Indian Academy of Science* (Plant Science) 90: 203-205. 1981) from Karnataka state. Hooker dealt with seven species of this genus in the Flora of British India which include four species described by Gamble.

Most of the species dealt with by Gamble are not represented in the herbarium of Botanical Survey of India, Southern Circle, Coimbatore (MH). Due to their restricted distribution, tiny nature of the species, tubers being eaten away (evidenced by the disturbed habitat) by wild animals like hare, rats, Wild boar etc. grazing and trampling by domestic as well as wild animals are some of the probable reasons for their poor representation in herbaria.

However I could locate one of the species, *Brachystelma glabrum* Hook. f. among the grass patches along water drips on open rocky slopes in Shevaroy hills, Salem district, Tamil Nadu when I visited the hills for collection of rare/endemic/threatened plants under the Project on Study Survey and Conservation of Endangered species of Flora (POSSCEF). This is one of the rare endemic species of south India, not represented in MH. Hence a short description is given below for better understanding as well as for recording the new location of this rare species. The specimens have been deposited in MH. A few live plants with tubers have been introduced in the experimental garden, Botanical Survey of India, Yercaud.

Brachystelma glabrum Hook. f. Fl. Brit. India 4: 65. 1883; Gamble Fl. Pres. Madras 598. 1957 (repr. ed.) (ASCLEPIADACEAE).

A short slender, glabrous, tuberous herb with erect stems up to 10-15 cm high; branches 2-3 at top. Tubers globose to some what flat, 2.5-4.0 × 1.5-2.5 cm. Leaves 4-16, 3-5 cm,

opposite, decussate, linear-lanceolate, acute, glabrous except the hirsute midrib beneath and upper margins, crowded at the end of branches. Bracts 2, leafy, slightly longer than pedicel during flowering. Flowers in terminal umbels of 2-3 whorls; pedicels 3 mm in flower, 5-6 mm in fruits, hirsute. Calyx-lobes 5, linear-lanceolate, acute. Corolla brownish-yellow; lobes 4-5, linear, obtuse from broad base, glabrous. Corona shortly toothed without subulate process. Fruits of 2 very slender, smooth, divaricate follicular mericarps 3-4 cm, tapering at both the ends, somewhat flat in the middle.

Gamble (l.c.) reported this species from Deccan hills of the Cuddapah district based on the collection of Beddome but I collected this species from Shevaroy hills of Tamil Nadu extending its distribution to further south.

Specimens: Tamil Nadu: Salem district, Shevaroy hills, Kakka Shola-canteen area, 7-6-1983, *Vajravelu* 77732 (Flowering and Fruiting); from the same area, 29-8-1983, *Vajravelu* 77740 (Fruiting).

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I thank Shri A. V. N. Rao, Orchidologist, National Orchidarium and Experimental Garden, Botanical Survey of India, Yercaud, Salem district, Tamil Nadu, for his help and for deputing Shri Allimuthu, Fieldman during the plant collection work.

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March 5, 1985.

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38. NOTES ON THE DISTRIBUTION OF RARE AND LITTLE KNOWN *CAREX ROSTRATA* STOCKS FROM NORTH-WEST HIMALAYA

(*With two text-figures*)

Carex rostrata Stocks (Cyperaceae) was previously collected by E. T. Atkinson during Sept. 1874, from the Himalayan region (Herbarium No. 24169 C and D Cal.), and for more than a century, there was no record on the distribution of this species from North-West India, specially from Himalayan region. Recently, the species has been collected by us from an interior part of Garhwal Himalaya. The plant has fodder, religious and local medicinal value.

In the present text, a note on the distribution, a brief description with figure of the species has been incorporated. The specimen has been deposited at the Botanical Survey of India, Northern Circle, Dehradun (BSD) and Herbarium Garhwal University, Srinagar (GUH, 5614).

Carex rostrata Stocks in With. Arrang. Brit. Pl. *ed.* 2. 2: 1059, 1787; Kuekenth. in Engl., Pflanzenr. 4 (20): Heft 38: 720, 1909 (excl. syn.). (Figs. I & II).

Carex obtusangula Retz. Fl. Scand. Prodr. 223, 1779.

C. bifurca Schrank, Baier. Fl. 1: 304, 1789.

C. ampullacea Gooden. in Trans. Linn. Soc. Bot. 2: 207, 1794; Kunth. Enum. Pl. 2: 494, 1837.

C. longifolia Thuill. Fl. Paris ed. 2: 490, 1790, non Host. 1809.

C. inflata Sut. Fl. helv. 2: 265, 1802, non Huds. 1762.

C. vesicaria sensu Clarke in Hook. Fl. Brit. Ind. 6: 740, 1894, *auct non* Linn.

FIG. I

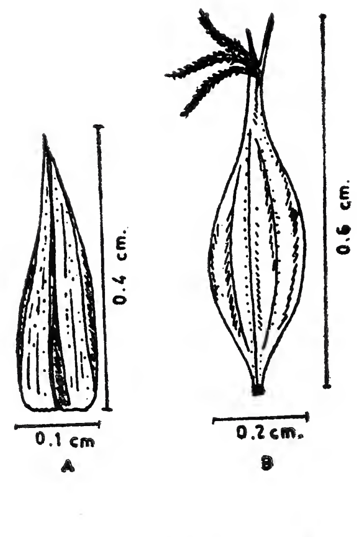

FIG. II

Carex rostrata Stocks
Fig. I. Flowering spikes (male and female).
Fig. II. A. Glume; B. Utricle.

A glabrous loosely tufted herb. Rhizomes woody, stoloniferous. Stem erect, compressed, 3-gonous, angles obtuse, 35-75 cm long, 0.2 cm thick, ribbed, glabrouse, covered at base by leaf sheaths. Leaves basal and sub-basal exceeding the stems, flat or revolute on margins, 0.3-0.6 cm wide. Sheaths thick, dark-brown black, slightly concave at mouth. Inflorescence consisting of 5-7 spikelets, upper 1-4 spikelets male, linear, 2.0-6.0 cm long, yellowish-brown, dense flowered, remaining spikelets female or uppermost androgynaecous. Staminate part much shorter than the pistillate part, oblong-cylindric, 5.0-7.0 cm long, 0.2-1.0 cm wide, upper 2-3 spikelets approximate, sessile, lowermost dense-flower distant, peduncled; peduncles capillary, glabrous. Bracts of lower spikelets foliaceous, upper bracts reduced to glumes, hardly sheathing, auricled at base; auricles brown, thick. Female glumes oblong-lanceolate, flat, apex acute, emarginate, 0.2-0.4 cm long, 0.1 cm wide, brown shining. Utricles ellipsoid-obovate, trigonous, inflated, 0.4-0.6 cm long, 0.1-0.2 cm wide, many nerved, emarginate, abruptly contracted below into a beak; beak shortly bifid, glabrous.

Flowering & Fruiting: May-November.

Carex rostrata Stocks has been previously reported from Europe, Pakistan and Turkey and Western Himalaya (Jammu and Kashmir) in India. During a recent collection in July 1984-85 this species was collected from Khatling Glacier (Bhumka, 3200 m Tehri District), in North-West Himalaya at the elevation of 3200 m. The plant grows on open sunny and alpine slopes.

ACKNOWLEDGEMENTS

We are thankful to the authorities of BSI, Northern Circle, Dehradun for Herbarium consultation and to Dr (Mrs) Neelam Ghildyal for the help in identification of the plant. We are grateful to Deptt. of Environment, New Delhi for financial assistance.

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39. TWO NEW RECORDS OF GRASSES FROM ANDHRA PRADESH

(*With two text-figures*)

The grasses *Paspalum paspaloides* (Michx.) Scribn. and *Rhynchelytrum repens* (Willd.) C. E. Hubb. recorded here are not reported by earlier botanists from Andhra Pradesh. Illustrations and distinguishing characters are given for each of the species to facilitate their easy identification. The citation and comprehensive distribution data are included.

Rhynchelytrum repens (Willd.) C. E. Hubb. in Kew Bull. 1934, 110. 1934; Bor Grass. India 355. *Saccharum repens* Willd. Sp. Pl. 1. 322. 1798. *Tricholaena rosea* Nees Ind. Sem. Hort. Vratisl. 1835 and in Linnaea 11, Litt — Bericht, 129, 1837. *Rhynchelytrum roseum* (Nees) Stapf & C. E. Hubb. ex Bews. The World's Grasses 223, 1929. *Tricholaena*

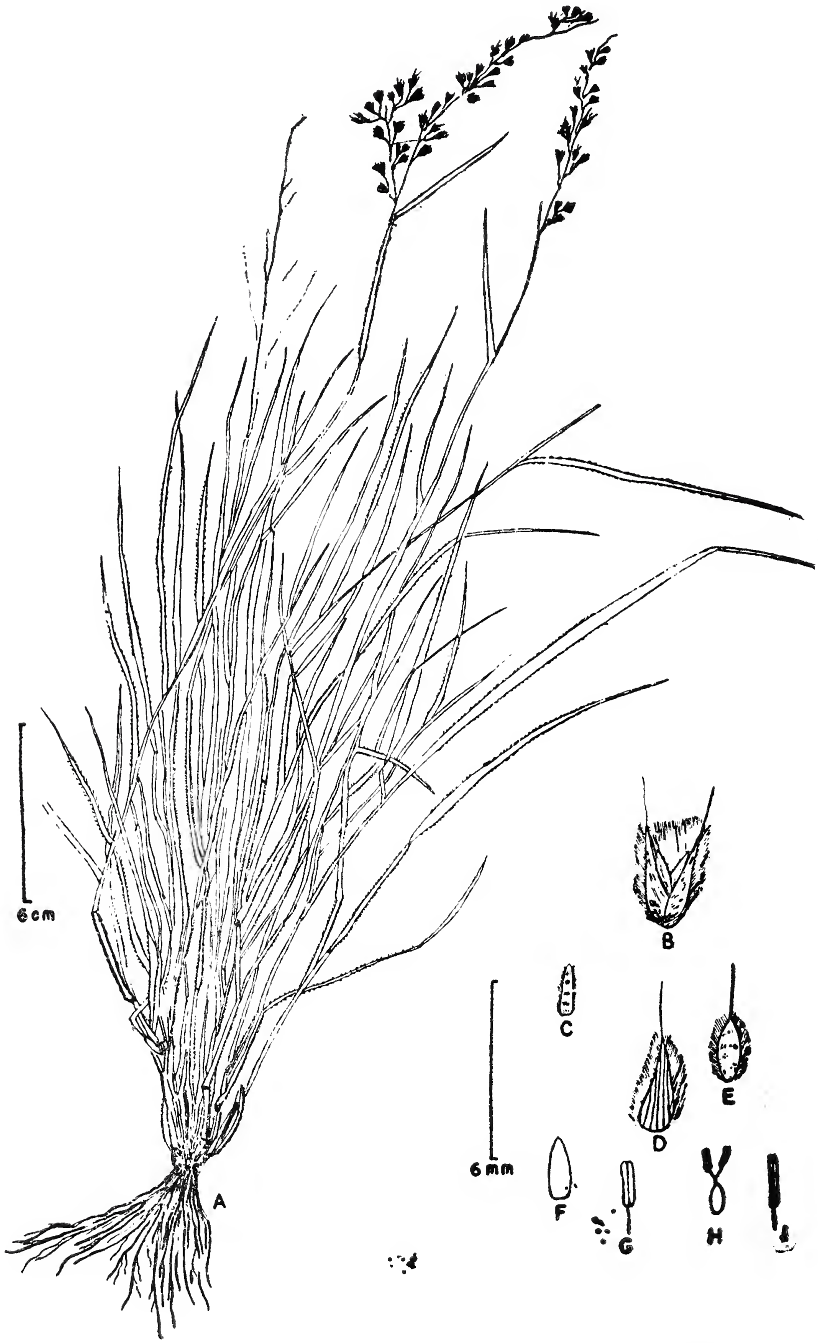

Fig. 1. *Rhynchelytrum repens* (Willd.) C. E. Hubb. A. Plant; B. Spikelet; C. Lower glume; D. Upper glume; E. Lower lemma; F. Upper lemma; G. Anther of lower floret; H. Ovary of Upper bisexual floret; I. Anther of upper floret.

repens (Willd.) Hitchc. Man. Grasses W. Indies (U.S.D.A. Miscl. Publ. no. 213. 331) 1936. (Fig. 1)

This grass can readily be distinguishable by its pink feathery panicles.

Flowering & Fruiting: August-November.

Distribution: ANDHRA PRADESH: Occasional in plains and lower slopes. *World distribution*: Tropical and South Africa.

Specimens examined: Kekathi RF (Anantapur district), *TP & NY* 783; Rangapuram RF (Kurnool district), *RVR & GO* 3352.

Paspalum paspaloides (Michx.) Scribn. in Mem. Torr. Bot. Club. 5. 29. 1894. *Paspalum distichum* auct non Linn. 1759. Bor. Grass. India 338; F.B.I. 7: 12. (Fig. 2).

A notable feature of this grass is that it possesses slender rhizomes and extensive stolons by means of which it forms loose mats near marshy habitats.

Flowering & Fruiting: September-November.

Distribution: ANDHRA PRADESH: A very common grass of marshy areas and often as a weed in rice fields. *World distribution*: Tropics and sub tropics of the world.

Specimens examined: Pennahobilam (Anantapur district), *TP & NY* 359; Vaddemanu (Kurnool district), *PVP & RVR* 2529.

Fig. 2. *Paspalum paspaloides* (Michx.) Scribn. A. Plant; B. Spikelet; C. Upper glume; D. Lower lemma; E. Upper lemma; F. Palea; G. Ovary and anthers; H. Caryopsis.

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March 5, 1986.

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T. PULLAIAH

40. RECTIFICATION OF THE POSITION OF *ANTHRAXON MICROPHYLLUS* (TRIN.) HOCHST. VAR. *HINDUSTANICUS* (JAIN & DESHPANDE) ALMEIDA & ALMEIDA

Arthraxon microphyllus (Trin.) Hochst. var. *hindustanicus* (Jain & Deshpande) Almeida & Almeida was originally described as a variety of *A. lancifolius* (Trin.) Hochst. by Jain & Deshpande (*in* Jain 1972). Almeida & Almeida (1985), who supposed that *A. lancifolius* was synonymous with *A. microphyllus*, have provided a new combination for var. *hindustanicus*. All unifications of the two species were performed without study of the types, e.g. the one by Hackel (1889) on which Almeida & Almeida based their decision. A study by Jain (1971) of the type material of *A. microphyllus* (present in herbarium of Leningrad) revealed that both species are distinct. This view was followed by Bor (1972; his *A. sikkimensis* is a synonym of *A. microphyllus*) and by myself (van Welzen 1981). Consequently *A. microphyllus* var. *hindustanicus* is a synonym of *A. lancifolius* var. *hindustanicus*, one among the numerous synonyms within *Arthraxon*; in my revision I was even unable to recognize any varieties within *A. lancifolius*.

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RECORD OF TWO UNIQUE OBSERVATIONS OF THE INDIAN CHEETAH IN *TUZUK-I-JAHANGIRI*[1]

DIVYABHANUSINH[2]

The Mughal Emperor Jahangir, who ruled from 1605 to 1627 A.D., was an enigmatic person deserving the highest attention of any Naturalist. Inheritor of a large empire and successor to Akbar the great, he had the leisure, inclination and talent to hunt and observe Nature with such an astonishing accuracy that one would ascribe his observations to a scientific investigator of a later date. His memoirs, the *Tuzuk-i-Jahangiri*, are replete with descriptions of hunts, animal behaviour, plants, fruits and even of a comet and a meteorite. He went to the extent of having some of his trophies weighed, measured and recorded, and in some cases, had them even dissected in his presence to satisfy his ever curious mind.

Unlike his father, Emperor Akbar, who caused his reign to be chronicled by his cour-[illegible]r Abul Fazl, Jahangir chose to write his [illegible] memoirs like his great-grandfather Babur. This he did in his own hand for the first 16 years of his 22 year reign. Many manuscripts survive but for the purpose of this article we shall confine ourselves to the edition of Sayyid Ahmad printed in Ghazipur in 1863 and Aligarh in 1864 which is accepted as the authentic version. It was translated into English by Alexander Rogers and edited by Henry Beveridge and published between 1909 and 1914.

I. In the third year of his reign (1608 A.D.), the Emperor records the following event:

'On this day[3] Raja Bir Singh Deo brought a white cheeta to show me. Although other sorts of creatures, both birds and beasts, have white varieties, which they call *tuyghan*, I had never seen a white cheeta. Its spots which are (usually) black, were of a blue colour, and the whiteness of the body was also inclined to bluishness. Of the albino animals that I have

[1] [illegible]ccepted March 1986.

[2] [illegible]umber One, Man Singh Road, New Delhi-11.

[3] Saturday, 21st March or Sunday, 22nd March. The text is confusing about the day and date, though the month is not in doubt.

seen there are falcons, sparrow-hawks, hawks (*Shikara*) that they call *bigu* in the Persian language, sparrows, crows, partridges, florican, *podna* (*Sylvia olivacea*) [sic.], and peacocks. Many hawks in aviaries are albinos. I have also seen white flying mice (flying squirrels) and some albinos among the black antelope, which is a species found only in Hindustan. Among the *chikara* (gazelle), which they call *safida* in Persia, I have frequently seen albinos" (Rogers and Beveridge, pp. 139-40, Vol. I, 1909).

Let us look closely at the passage and see what it portends. The Emperor wrote his memoirs in Persian and the words for the white cheetah in the text are *yuz-i safed.* The Persians like the Arabs used the cheetah (*Acinonyx jubatus*) for hunting and distinguished it from the panther by giving it a distinct name. In Persian the word is *yuz* while in Arabic it is *fahd.* On the other hand, the much confused panther or leopard (*Panthera pardus*), was identified by the Persian word *palang* and by the Arabic word *namir* respectively. Jahangir was a keen hunter, who often hunted with cheetahs in the tradition of his father. It is inconceivable for anyone familiar with his life and times to believe that he could have confused the two *Safed,* ofcourse, means white.

It is pertinent to note that even *Maasir-i Jahangiri,* a chronicle of Jahangir's reign written by one of his courtiers Khwaja Kamgar Husaini, also records this event and does so precisely though it is silent regarding the other white birds and animals seen by the Emperor (Alavi, p. 113, 1978).

It is therefore strange that Alvi and Rahman (p. 51, 1968) have taken the words to mean a snow leopard (*Panthera uncia*). Raja Bir Singh Deo was from Orcha in Central India. It is most unlikely that he would have come across a snow leopard in his life. On the other hand his area must have had a large cheetah population if blackbuck (*Antilope cervicapra*), cheetahs' main prey, were any indication. British naturalist-sportsmen reported seeing groups of these antelopes of a thousand strong upto the days of the Mutiny (Forsyth, p. 60, 1886). Actually, it is recorded that cheetahs were caught from Mughal hunting grounds some 90 kilometres north-west of Orcha and elsewhere in Central India (Habib, Sheet 8B, 1982). It is more likely that a snow leopard (if there was one) would have accompanied as Himalayan prince whose name could not have ended with the suffix "singh deo" which is found only in a tract of land from Central India to Orissa.

The *Tuzuk-i-Jahangiri* text under reference gives the name as Raja Narsingh Deo. A person by this name does not feature otherwise in the life of Jahangir. Whereas, Raja Bir Singh Deo of Orcha was a close confidant of Jahangir, a frequent visitor to the imperial court and indeed the nemesis of Abul Fazl at the instance of Prince Salim. In all probability, the slip has occurred in transcribing the text from the original.[4] However, *Maasir-i Jahangiri* in its account gives the name correctly as Raja Bir Singh Deo (Alavi, p. 113, 1978).

Further, the passage describes in detail the "blue" spots and the whiteness of the body of the animal. In other words, the animal lacked pigmentation of its hair except the light or blue spots, and nor does Jahangir comment on the colour of its eyes. If there was something unusual about them, would the emperor

[4] Such a slip has also occurred in Amal-i-Saleh a chronicle of Shah Jahan's reign (Yazdani, p. 123, Vol. II, 1927). The name of Jhujhar Bundela's father is given as Nar Singh Deo while it is well known that he was the son of Raja Bir Singh Deo. Obviously the transcriber/editor has confused the word "Bir" with "Nar" which when written in Persian looks almost alike with a difference of only the dots for the letter, "noon" (Above) and "ba" (below).

have omitted its description? To illustrate the point let me quote Jahangir's reaction on seeing a Zebra at his court in the fifteenth year of his reign (1620 A.D.): "I saw a wild ass (*gur-khar*), exceedingly strange in appearance, exactly like a lion [sic.]. From the tip of the nose to the end of the tail, and from the point of the ear to the top of the hoof, black markings, large or small, suitable to their position, were seen on it. Round the eyes there was an exceedingly fine black line. One might say the painter of fate, with a strange brush, had left it on the page of the world. As it was strange, some people imagined that it had been coloured. After minute enquiry into the truth, it became known that the Lord of the world was the Creator thereof" (Rogers and Beveridge, p. 201, Vol. II, 1914).

To get back to the cheetah, Jahangir was so astonished at the sight of this particular animal, that he lists all the white animals and birds he had seen and comments with wonder that he had never seen such an animal before. The passage in question should be looked at more closely as the Rogers and Beveridge translation is not as accurate as one would have wished.

In describing the animal's spots the Persian text uses the words *neela rang,* i.e. blue colour. In the translation it is stated that the whiteness of the body "was also inclined to bluishness". However, a more accurate rendering would have been "inclined to (*hamagi mail dasht* in Persian) the same colour" (i.e. of the spots). The passage from *Maasir-i Jahangiri* which records the same event when translated reads thus: "Raja Bir Singh Deo brought to the emperor a white cheetah. Its spots which are normally black, were of blue colour, and the whiteness of its body was also inclined to bluishness" (Alavi, p. 113, 1978)[5].

In other words the white of the body had a tinge of blue. The light spots of the animal could have looked bluish with the white areas of the body tinged with the same colour with a side light falling on it. This is noticeably the case with the stripes of a white tiger.

In the translation the word albino is used at three places. However, in each case the word in the text is *tuyghan* which is a Turkish word and means white. A white animal can be either a mutant or an albino, as such, the translation is misleading. Now let us look at the white birds and animals seen by the Emperor: (a) *Shahin* (translated falcon) is derived from the Persian *Shah een asth* meaning a "king among raptors", it is *Falco peregrinus*; (b) *Basha* (translated Sparrow-hawk) is *Accipiter nisus*; (c) *Shikara* (translated hawks) is *Accipiter badius*; (d) *Kunjashk* (translated sparrows) is a general term in Persian for many small birds but it is mainly applied to sparrows; (e) *Za-gh* (translated crow) can be a jungle crow *Corvus macrorhynchos,* or a house crow *C. splendens,* or a carrion crow *C. corone,* or a raven *C. corax*; (f) *Kabk* (translated partridge) is the Persian chukor, *Alectoris chukar*; (g) *Durraj* (translated florican) is the grey partridge, *Francolinus pondicerianus*; (h) *Podna* or *bodana* is the grey quail, *Coturnix coturnix*; (i) *Taus* (translated peacocks) is the common peafowl, *Pavo cristatus*; (j) *Baz* (translated hawks) is the goshawk, *Accipiter gentilis*; (k) *Mush-i paran* (translated flying mice, flying squirrel) can be any one of the eleven different forms of flying squirrels found in the sub-continent; (l) *Ahu-i siyah* (trans-

[5] The editor has written the sentence as *"safedi-ye badan-i u niz mail-ba milki dasht"*. This in my opinion is an error in transcribing the text. The word *milki* here appears to be meaningless. There is a strong possibility that this word is *nilaki* which when written in Persian resembles very much the word *milki. Nilak* in Persian means bluish, a little blue.

lated black antelope) is the blackbuck, *Antilope cervicapra*; (m) *Chikara* (translated gazelle) is the Indian Gazelle, *Gazella gazella.*

It is apparent from the foregoing that Jahangir took great care to write this passage for, the event he was recording was unique indeed. What he was describing is a mutant cheetah rather than an albino. At any rate this is the only known record of a white cheetah throughout history.

Jahangir made a practice of commissioning his court painters to paint interesting birds and animals. For example, a turkey (*Theleagris gallapova*) reached his court from Goa. Not only did Jahangir order his painters to paint it, but also he went to great lengths to describe it, for he found the bird strange (Rogers and Beveridge, pp. 215-17, Vol. I, 1909). In another instance, Jahangir was so impressed by a falcon [identified by Dr. Salim Ali (Das 1983) as a red capped or Barbary falcon (*Falco peregrinus babylonicus*)] that was presented to him, that he specifically instructed his Master painter Mansur, to paint it even after the bird had died (Rogers and Beveridge, pp. 107-8, Vol. II, 1914). Both these paintings survive, the former is preserved at the Victoria and Albert Museum, London, while the latter is at the Maharaja Sawai Man Singh II Museum, Jaipur.

The memoirs make no mention of the white cheetah (or for that matter any of the other white birds or animals recorded in the passage) being painted. In this context, it may be noted that many animals and birds were painted by Jahangir's painters of which there is no mention in the memoirs. Thus to mention but two startling instances, there is a painting of a Mauritius dodo (*Raphus cucullatus* L.) considered by Dr. Salim Ali "to be the most scientifically accurate one extant" (Alvi & Rahman, p. 17, 1968), and there is a remarkably accurate painting of a Siberian crane (*Grus leucogeranus*) done one hundred years before the bird itself was scientifically described by Peter S. Pallas (Sauey 1981). Both these paintings are attributed to Ustad Mansur and fortunately both survive to this day, the former is preserved at the Hermitage, Leningrad, while the latter is at the Indian Museum, Calcutta. Did Jahangir have the white cheetah painted by one of his master painters? Did his court painters paint this rare animal as a matter of course? These questions must remain unanswered as such a painting has not been reported.[6]

[6] There are other instances of white birds and animals recorded by the Mughals some of which may be noted: (a) Jauhar Aftabchi, Humayun's ewer bearer, who chronicled his master's life during the reign of Emperor Akbar, notes that Humayun ordered his painters to take the likeness of a white bird encountered by him (Das 1983). (b) The illustrated royal copy of the *Akbarnama* preserved in the Victoria and Albert, Museums, London contains a painting of Akbar slaying a tigress (*Panthera tigris*) near Gwalior in 1561 A.D. Two of the five sub-adult cubs slain with the mother are white (Divyabhanusinh 1986). (c) Emperor Jahangir himself received a gift of five *"tuyghun"* (White) *Baz* (*Accipiter gentilis*, could they have been *A. g. albidus* of which form "about 50% are white with pale bars"? Brown and Amadon, p. 454, Vol. II, 1968) erroneously translated as falcon, from Transoxiana in the thirteenth year of his reign, 1618 A.D. (Rogers & Beveridge, p. 10, Vol. II, 1914). (d) A white elephant (*Elephas maximus indicus*) reached Akbar's court from Arakan and a painting of this animal survives. Another white elephant reached Emperor Shah Jahan according to the *Padshah Nama.* (Chandra 1955-56) and there is a painting of "Dara Shikoh on a pink elephant" attributed to the famous painter Bichiter dated C 1628-30 A. D. (Beach, p. 105, facing p. 176, 1978). (e) A Mughal album of Emperor Aurangzeb's time preserved in Maharaja Sawai Man Singh II Museum, Jaipur, contains a painting which has an albino house crow and a partial albino house crow (*Corvus splendens*) according to the identification done by Dr. Salim Ali (Das 1983).

II. In the eighth year of his reign (1613 A.D.), the Emperor records the following event:

"It is an established fact that cheetahs in unaccustomed places do not pair off with a female, for my revered father once collected together 1000 cheetahs. He was very desirous that they should pair, but this in no way came off. He had many times coupled male and female cheetahs together in gardens, but there, too, it did not come off. At this time a male cheetah, having slipped its collar, went to a female and paired with it, and after two and a half months three young ones were born and grew up" (Rogers and Beveridge, p. 240, Vol. I, 1909). *Maasir-i Jahangiri* records this event as well, and it contains exactly the same information (Alavi, p. 169, 1978).

This passage of the *Tuzuk-i-Jahangiri* is well-known and it has also been noted by scholars in the past (e.g. Ali 1927, Alvi and Rahman, p. 44, 1968). However, there are certain unique aspects of the event recorded in it which have been overlooked.

Firstly, this is the only record in history of trained cheetahs breeding. That these were Indian cheetahs makes it truly unique. Secondly, this is the only known instance of cheetahs breeding in captivity anywhere until the second half of this century. Philadelphia Zoo, U.S.A. bred African cheetahs in 1956 (Eaton, p. 33, 1974) thus, becoming the first to do so in captivity in our time. The period of gestation according to Jahangir was 75 days plus, for he records that the birth of 3 cubs took place "after two and a half months". No record is available of the breeding habits of the Indian cheetahs in the wild (Prater, p. 81, 1948)[7] while this is the only recorded instance in captivity. Information is available however, on the African cheetahs. In twelve instances observed between 1964 and 1968, the period of gestation varied between 86 and 95 days (Eaton, p. 30, 1974). Twentysix instances of births were recorded among African cheetahs in captivity between 1956 and 1971. Of these, in 14 cases only a single cub was born, in 6 cases the litter was of 2 cubs each and in 6 cases the litter was of 3 cubs each (Eaton, p. 33, 1974). Thirdly, it is important to note that these cheetahs mated, conceived and produced cubs in captivity without any artificial interference, inducement or assistance. In fact, imperial attempts to induce breeding among cheetahs failed during the time of Emperor Akbar as the passage records. Finally, it is noteworthy that the cubs survived and grew up.

Actually, the rarity of this event was not lost on the ever so keenly observant Emperor though he did not have the benefit of our knowledge. He concludes this passage with the statement: "This has been recorded because it appeared strange" (Rogers and Beveridge, p. 240, Vol. I, 1909).

[7] There is a tantalising miniature painting dated C 1570 A.D. and tentatively attributed to Akbar's famous painter Basawan, of "A family of cheetahs in a rocky landscape". Its contents are described thus: "The mother lying in a glade, suckling one of her four cubs while grooming another, the other two playing in the foreground, the male cheetah lying amongst rocks on the right, a tree on the left with two palm squirrels, a pair of birds, and a monkey who watches the cats with interest" (Falk, Frontispiece, p. 18, 1978).

There are many paintings of cheetahs of the Mughal period but these are of hunts, court scenes, and such like. This is the only known surviving instance of a painting depicting a cheetah family in their natural surroundings. It may be possible that the animals portrayed here were studied from tame specimen. Yet it is a known fact that Mughal painters had personal field knowledge of animals in the wild since they accompanied their royal masters on hunts, travels and expeditions. Could this painting be the record by the painter of a natural scene observed by him? If so, we have a litter of four cubs in an Indian cheetah family in the wild.

Acknowledgements

I am grateful to Dr. Asok Kumar Das, Director, Maharaja Sawai Man Singh II Museum, Jaipur, for drawing my attention to the passage of the white cheetah in the *Tuzuk-i-Jahangiri*; to Dr. Muzaffar Alam of Jawaharlal Nehru University, New Delhi, who helped in examining the Persian texts; to Mr. Mohamad Osman Amir of Dehra Dun who helped me to identify the birds and animals mentioned in the passage; and to M. K. Ranjitsinhji who read the draft of the article and made valuable suggestions.

Their generosity has greatly contributed to the making of this article. However, I am solely responsible for inaccuracies if any.

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BIRDS OF DEFORESTED HILLS[1]

PRAKASH GOLE[2]

(*With two text-figures*)

The hills of Western Ghats south of Bombay (roughly between latitude 18°N to 19°N) present more or less a very barren aspect. Large trees or groves of trees are few and far between and extensive tracts even lack shrubbery. During the rainy season these hills are covered with grass but as the dry season is ushered in, grazing and lack of moisture take their toll, grass withers, shrubs wilt and the soil is exposed to the full impact of the sun and the wind. Just before the rainy season, dried grasses are set afire presumably in the hope of getting a luxuriant cover of grass once again.

Rainfall in these hills ranges from 9000 mm to 2000 mm per year and decreases rapidly from west to east. Inspite of a prolonged dry season which lasts roughly from October to May, the annual rainfall appears to be sufficient to cover these hills with a varied forest, yet the hills present a barren aspect today.

When and how the process of deforestation of these hills began is nowhere documented in detail. The process might have begun in the closing years of the last century and gradually gathered momentum. For, in the nineteen-thirties one Mr. Garland, a forest officer, in his working plan of Pune District has expressed surprise in finding these hills so barren and bereft of trees (Garland 1934). It means that even more than fifty years ago these hills lacked tree-cover to any appreciable extent.

[1] Accepted June 1985.

[2] 1B, 'Abhimanshree' Society, Pashan Road, Pune-411 008.

What could be the causes that led to deforestation of these hills? The same forest officer's remarks are interesting enough. He says, "In the west (i.e. in Western Ghats) the main influence of man appears to be due to shifting cultivation and in the east due to grazing and cutting for fuel and house timber. Burning for obtaining a grass crop is also evident wherever rainfall is above or about 70 cm." (Garland, loc. cit.). These remarks aptly describe the conditions in Western Ghats in the area which I have been studying for the last two years. This area is the 120.80 sq. km. catchment area of the Panshet dam located about 42 km to the west of Pune city. The Panshet reservoir supplies drinking water to the city as well as irrigation to the areas further to south-east in the direction of Solapur. The dam is built on the river Ambi which is a tributary of the river Mutha which flows through Pune city. The Ambi originates near Dapsar on the main ridge of Western Ghats at a height of about 1200 metres. It flows west through the hills for a distance of about 30 km to Panshet where its valley is reduced to a narrow neck facilitating the construction of the dam.

Before the dam was built the peasants of the Ambi valley cultivated rice on the valley floor which was fertile and practised shifting cultivation on the lower and middle slopes of the surrounding hills by clearing the vegetation but sparing such economically important trees as mango (*Mangifera indica*) and Hirda (*Terminalia chebula*). Forest of moist deciduous

to semi-evergreen type of trees was mainly restricted to upper hill slopes and was categorised as reserve forest. Due to lack of transport facilities these forests were not worked. But when it was decided to construct the dam, a road was built to link Panshet with Pune. As the valley floor was going to be submerged the cultivators sold off the trees standing on their lands to timber and charcoal merchants of Pune who could cart away the wood in trucks thanks to the construction of the road. The contractors from the city even bought out the trees on lower and middle slopes leading to their almost complete deforestation (Gadgil 1979). The people whose lands were submerged under the reservoir were asked to resettle on the stony, dry plateaus near Dhond south-east of Pune near the end of the command area. Many of them returned to Panshet catchment, being unable to adjust to the new surroundings and populated the slopes above the reservoir level where they began the age-old practice of shifting cultivation for hill millets, and became dependent on this type of cultivation having lost their paddy fields under the reservoir. They even encroached upon the reserve forest areas for their fuel needs, timber and to a lesser extent for grazing their cattle. Consequently most of the reserve forest areas have been cut up and burnt. The only redeeming feature in this picture of deforestation is the presence of certain sacred groves which are dedicated to tribal deities and are not to be overtly cut.

Physical Character of the Hills:

The hills of the Panshet catchment area form part of the great trap region of the Deccan Plateau. The general aspect of the hills is very rugged and much cut up by gorges and ravines, through which a number of streams, many of them only seasonal, flow. Beyond Dapsar (see Fig. 1) near the western end of the catchment, the descent to the Konkan from the main ridge of the Ghats, is abruptly precipitous. But to the east the hills taper off gradually, though till Panshet their character remains fairly rugged and difficult of access.

Basalt or Deccan trap which is the result of volcanic lava flows, occupies the hills in the catchment area. It is normally dark grey or blue grey in colour. The rock weathers into a disintegrated form known as *Murrum* and finally produces soils of varying depth, texture and colour. The red soils are common in these hills. They are generally shallow and coarse and often spoilt by a mixture of gravel. Soils produced from *Murrum* mostly lack in humus, are non-acid and naturally well-drained by the under-lying *murrum*.

The Western Ghats present a formidable barrier to the monsoon winds that come in from south-west after collecting a lot of moisture over the Arabian sea. Thus during the rainy season the effect of the ridge of Western Ghats on the western boundary is not only to cause excessive precipitation on the ridge itself, but also to create a rain-shadow to leeward side so that there is an amazingly sudden drop in rainfall on the eastern side. This is well illustrated by the rainfall data given in Table 1.

In the table the year 1960 was the year when the dam was almost complete and water was impounded for the first time. I began the present study in July 1983 and the other years in the table present rainfall data of the period just preceding the year 1983. The four rain-gauges are located to the west of the dam site, i.e. Panshet is near the dam site; Shirkoli and Mangaon are respectively further to the west and Dapsar is at the western end of the catchment, just below the crest-line of the main ridge.

It will be seen from Table 1 that village Dapsar which is situated near the western end

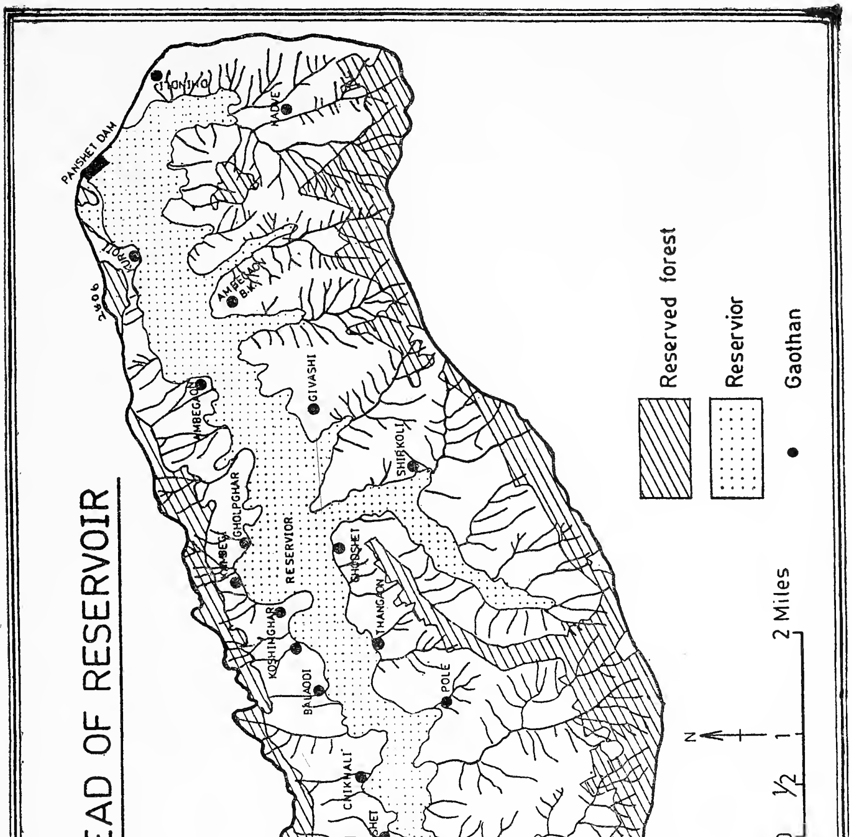
PANSHET CATCHMENT: SPREAD OF RESERVOIR
PANSHET DAM
RESERVIOR
GIVASHI
SHIRKOLI
THANGAON
POLE
CHIKHALI
GHODSHET
KASEDI
GONDEKHEL
KURTWADI
DAPSAR
TEKPOLE
MANGAON
KOSHINGHAR
GHOLPGHAR
Reserved forest
Reservior
Gaothan
N
0 ½ 1 2 Miles
TANAJI SAGAR CATCHMENT
CATCHMENT AREA 47·0 Sq.MILES
(120·80 Sq.Km.)
TALUKA VELHE

Fig. 1.

TABLE 1

THE PATTERN OF ANNUAL RAINFALL IN THE STUDY AREA

	Panshet		Shirkoli		Mangaon		Dapsar	
Year	Monsoon Rainfall	Annual Rainfall	Monsoon Rainfall	Annual Rainfall	Monsoon Rainfall	Annual Rainfall	Monsoon Rainfall	Annual Rainfall
1960	1787.64	—	2829.6	3000.0	4473.70	—	6352.49	6352.49
1977	1816.70	1952.5	3348.9	3381 2	4528.90	—	7056.20	7056.20
1978	2057.60	2156.9	2931.0	3009.2	7479.20	7501.3	8842.20	9602.40
1979	1891.40	2042.7	2835.73	—	4117.20	4229.2	8456.60	9042.60
1980	2504.20	2615.7	5003.80	5052.5	6941.20	6790.8	14577.90	14648.80
1981	2284.80	2674.4	3691.6	3697 0	4682.10	4712.5	9758.0	9758.0
1982	1241.50	1499.90	3388.6	3641 80	3580.20	3750.0	7557.4	7897.0
Total	13583.84	12942.10	24029.23	21782.70	32802.50	27233.8	62600.79	64357.49
Average	1940.54	2157.0	3432.74	3630.45	4686.07	5446.76	8942.97	9193.92

Source: Irrigation Department, Govt. of Maharashtra.

of the catchment, experiences an average annual rainfall of 9193 mm. Further east at Mangaon and Shirkoli the average annual rainfall drops to 5446 mm and 3630 mm respectively. While still further east at Panshet the annual average drops to 2157 mm. As said above the dry season begins in October and continues till the end of May during which temperatures vary between 17°-18°C to 35°-37°C. In the absence of biotic interference the character of vegetation and birds should correspond to the climatic conditions. In such climatic conditions the character of vegetation in the catchment may probably vary from dry deciduous in the east to evergreen in the extreme west where the rainfall is the highest. However, biotic disturbances make it difficult to identify natural climax vegetation. It can only be guessed from a study of the vegetation of groves sacred to temples as vegetation in these sacred groves has remained more or less undisturbed over a considerable period of time, and of forest patches found in certain inaccessible situations. The varied nature of vegetation existing over the remainder of the catchment may also help in this guesswork. Likewise the bird-life of sacred groves and that found in remote forest patches may provide clues to the character of bird-life that should prevail in this region in the absence of biotic interference. But before we consider the character of vegetation in greater detail, it will be convenient for our purposes to divide the study area into smaller manageable segments.

The Three Zones:

Three factors namely, the rainfall, the character of vegetation and the degree of influence of biotic factors, have been taken into account in dividing the catchment into three zones. The first zone extends from the dam site to village Givashi (see Fig. 2) on the right bank of the river Ambi and Ambegaon Khurd on its left bank. This zone with an annual average rainfall between 2000 and 3000 mm has been subjected to maximum pressure from biotic factors and presents a denuded and devastated aspect. The second zone extending westwards from Ambegaon Khurd and Givashi and reaching Kasedi on the left and Mangaon on the right bank, bears an average annual rainfall of 3100 to 6000 mm and may be termed as a buffer zone between the low rainfall first zone and the high rainfall third zone, lying still to the west. The third or the last zone which includes the source region of the river Ambi stretches westward from Mangaon and Kasedi to the crest-line of the main ridge of the Western Ghats. The annual average rainfall in this zone ranges between 6001 mm to over 9000 mm.

Vegetation of the Three Zones:

The first zone presents an aspect of intense devastation and denudation. As biotic influences are severe, a sub-climax with grasses as dominants and only scattered trees and shrubs has become established. Only a few mango trees are left standing and lands lying fallow have been run over by *Lantana camara* and less nutritive grasses like *Themeda quadravulvis* and *Heteropogon contortus.* The next in dominance is *Terminalia tomentosa.* But the stability of associations among the sub-climax especially the grasses, can be easily disturbed. Fires and variation of grazing and cutting incidence result in a constant series of sub-series. Other plants occurring in this zone include *Carissa congesta, Lasiosiphon eriocephalus* and *Vitex negundo.* As reserve forests have mostly been cut up Lantana has invaded these areas also. *T. tomentosa* and climbers like *Diascorea pentaphylla* and shrubs like *Solanum indicum* are the other plants commonly found in this zone. There are perhaps more trees around villages than in rest of the area of this

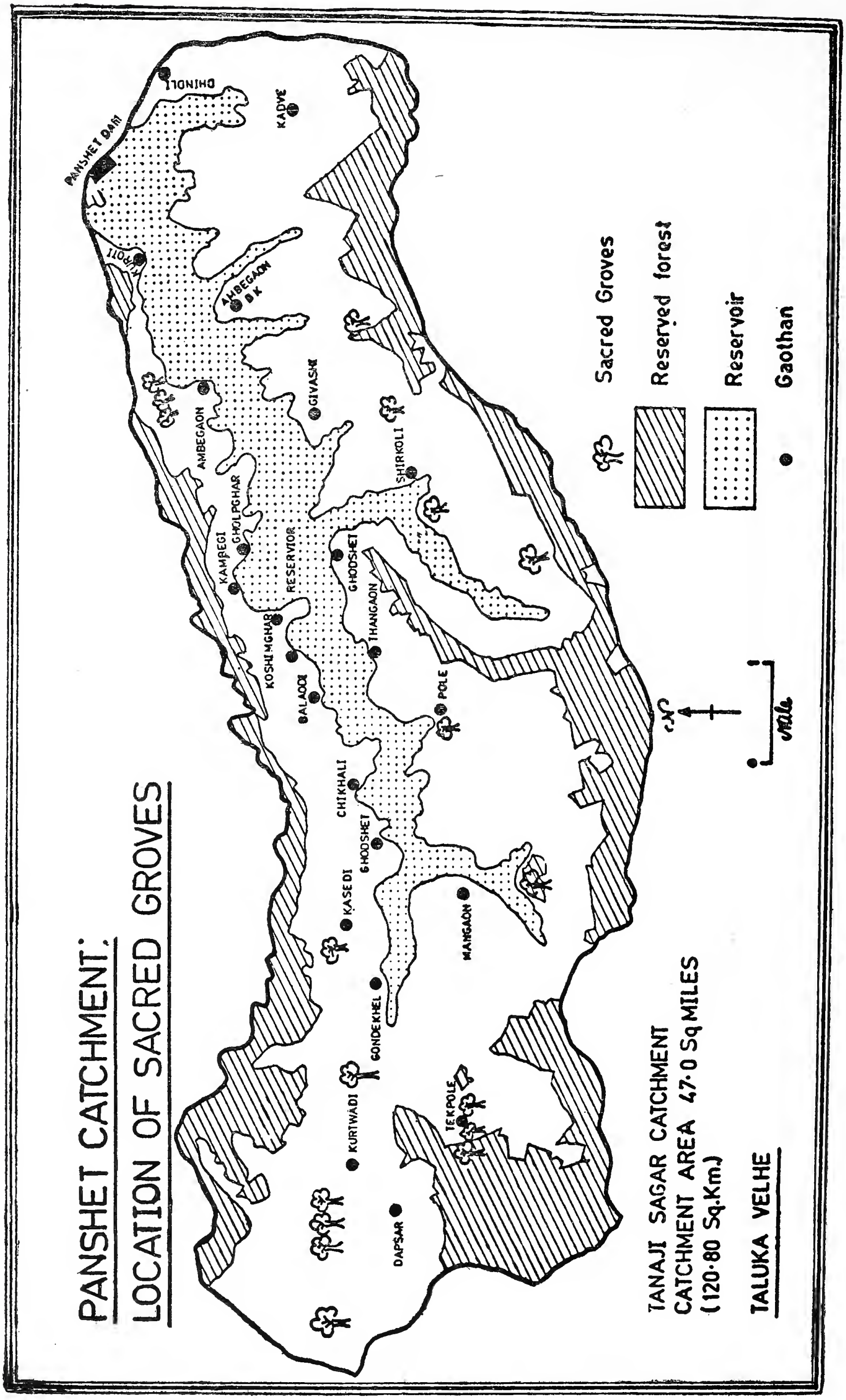
PANSHET CATCHMENT:
LOCATION OF SACRED GROVES
TANAJI SAGAR CATCHMENT
CATCHMENT AREA 47·0 Sq MILES
(120·80 Sq.Km)
TALUKA VELHE
Sacred Groves
Reserved forest
Reservoir
Gaothan
Mile
PANSHET DAM
CHINOLI
KADVE
KURPOTI
AMBEGAON BK
GIVASHI
AMBEGAON
SHIRKOLI
GHOLPGHAR
KAMBEGI
RESERVIOR
GHODSHET
THANGAON
KOSHIMGHAR
BALAODI
POLE
CHIKHALI
GHODSHET
KASEDI
MANGAON
GONDEKHEL
KURTWADI
TEKPOLE
DAPSAR

Fig. 2.

zone. They are mostly fruit trees such as mango and banana planted by the villagers. Here and there lone examples of *Alstonia scholaris, Salmalia malabarica* and *Erythrina variegata* stand as mute testimony to days gone by when the land was less intensely cultivated and conditions were moister.

The fallow period is as short as one year and slopes are cultivated almost annually in the first zone. As soil becomes exposed to wind and rain, it is quickly lost. Where erosion is particularly severe, rock is exposed and stony plateaux are the result. The slopes where erosion is less support grasses like *Themeda* and *Heteropogon* and herbs like *Smithea hirsuta, S. setulosa, Celosia argentea* and *Alysicarpus vaginalis.* These stony and grassy patches were seen to support their characteristic biid life too.

Near the western extremity of this zone on the right bank lies the Sacred Grove of Ambegaon Khurd. Vegetation in this grove remains more or less undisturbed over a number of years and may be said to exhibit vegetation typical of this zone if biotic influences did not have their full play. *Terminalia tomentosa, Vanqueria spinosa, Phyllanthus emblica, Bridelia retusa, Lagerstroemia microcarpa, Ficus glomerata, Bombax ceiba, Bauhinia racemosa, Cassia fistula, Albizzia procera* and *Randia dumetorum* are some of the trees commonly occurring in this grove. As will be seen later the grove harbours its peculiar bird-life also.

Grassy plateaux are not extensive in the second or the middle zone; though wherever they exist the dominant grasses are not different from those found in the first zone. The fallow period is longer in the second zone and the patches lying fallow for more than a year quickly lose their character as grassy plateau and are occupied by plants next in biological succession. *Lantana camara* has invaded areas in this zone also though not as much as in the first zone and is closely followed by *Carissa congesta, Meynea laxiflora, Lasiosiphon eriocephalus, Woodfordia fruticosa, Zizyphus rugosa, Emblica officinalis,* and *Syzygium cumini.* Around cultivated patches there are more trees left standing in this zone than in the first zone. Such trees include *Melia composita, Bridelia retusa, Erythrina indica, Butea monosperma, Terminalia tomentosa, Lagerstroemia microcarpa, Albizzia procera, Cassia fistula* etc. Around hamlets the fruit trees include mango, jackfruit and banana. Besides there are extensive thickets of Bamboo (*Dendrocalamus strictus*) which form a major source of income for the villagers. *Syzygium cuminii* and *Ficus glomerata* also occur commonly around hamlets.

There are certain areas in this zone which have remained fallow for more than five to seven years and thus support some characteristic vegetation. Here plants include *Vanqueria spinosa, Wrightia tinctoria, Randia dumetorum, Ficus retusa Olea dioica* etc. Here also shrubs and climbers such as *Strobilanthes callosus, Randia malabarica, Crotalaria triquetra, Jasminum malabaricum, Flacourtia latifolia* and *Pavetta indica* have enveloped the trees and have provided a peculiar habitat for birds. Steeper slopes are dominated by *Strobilanthes callosus* and *Ficus rumphii,* while reserve forest areas which are less cut up in this zone than in first, are dominated by *T. tomentosa* and *Strobilanthes.* Other plants found in these areas are *Actinodaphne hookeri, Carissa congesta, Embelia tsjeriam-cottam, Lasiosiphon eriocephalus, Xeromphis spinosa* etc. Some magnificent specimens of *Bombax ceiba, Alstonia scholaris, Terminalia belerica* and *Terminalia chebula* still remain in the more remote and inaccessible areas. Near Mangaon on the left bank and near the western end of this zone, lies the Sacred Grove dedicated to the deity *Janni.* Spread over an area of more than 16 ha

this grove provides refuge to a number of trees as well as displays a characteristic bird-life of its own. Trees commonly occurring in this grove include *Bombax ceiba, Terminalia belerica, T. chebula, Sterculia guttata, Memecylone edule, Acacia concinna,* (climber) *Actinodaphne hookeri, Macaranga peltata, Caryota urens, Mappia foetida* etc.

The vegetation of the third zone with its very high annual rainfall presents a peculiar aspect. Ideally, in the absence of biotic interference, evergreen forest should be the climatic climax in this zone. However, biotic influences coupled with a long dry period are factors adverse to the existence of a pure evergreen crop. A series of sub-climaxes is the inevitable result. In lands lying fallow for less than five years, while no plant could exert as much dominance as *Lantana camara* in the first zone, the following plants were found to be common: *Woodfordia fruticosa, Strobilanthes callosus, Carissa congesta, Embelia tsjeriam-cottam, Lasiosiphon eriocephalus,* and *Glochidion hohenackeri.* Where erosion is heavy and rock is exposed *Euphorbia neriifolia* has become established. Where the soil is poor and shallow a dwarf type of forest forms a sub-climax in which *Memecylone edule* remains dominant. *Syzygium cuminii* and *Actinodaphne hookeri* dominate in areas which are under some degree of protection. The hamlets in this zone, as in the middle, remain concealed among lush growth of Bamboo and fruit trees such as *Syzygium cuminii* and mango. There are sacred groves in this zone also though not as large as in the middle zone. For example, in the group of three sacred groves at Dapsar the plants commonly found include *Entada scandens, Mappia foetida, Actinodaphne hookeri,* and *Ficus sp.*

Bird-life in the Three Zones:

The character of vegetation should reflect the character of bird-life. Broadly speaking, the character of bird-life depends upon the availability of habitat. But in these hills a general lack of vegetation density and of botanical variety have restricted the availability of habitat. Human practices like shifting cultivation, cutting and burning of vegetation for clearing the ground and for making coal have created tension zones and disturbances which are not likely to be favourable to the existence of a varied avifauna. Further the valley floor stands submerged under a large and deep sheet of water. Water of considerable depth, steeply sloping and often rocky banks and lack of protective vegetation along the shoreline are also not conducive to birds. On this background therefore, the character of bird-life of these deforested hills has to be examined.

Very few birds were encountered on the deep, open sheet of water of the reservoir. A few Spotbill ducks, an occasional Little and a Large Cormorant and once a Blackheaded Gull were seen on the reservoir. As the reservoir water is let out during the dry season (usually from December onwards) and the water level goes down, Little and Median egrets, Common Sandpipers and Little Stints come to forage near the edges of water and the rapidly drying up mudflats. Common and Pied Kingfishers, Grey and Large Pied wagtails are also normally to be found along the water's edge. Whitenecked Storks and an Osprey have also been noted in sheltered bays and inlets of the reservoir. However, many other species that frequent aquatic and semi-aquatic habitats in the plains were never encountered in the catchment. It appears therefore, that these deep, open sheets of water in the mountains are not much favoured by birds presumably because they do not provide adequate food and shelter.

Birds in the I Zone:

It may be recalled that in this zone due to severe biotic pressures forests have been replaced by such habitat-types as thorn and scrub, rocky and grassy plateau, scattered trees and cultivation and village environs. In addition there were certain birds that were always observed only in flight. The sacred grove near Ambegaon Khurd constitutes a distinct habitat also. Table 2 sets out the distribution of birds recorded in zone I according to broad habitat-types.

In this table a particular habitat is assigned to a bird species if it is frequently encountered in it. This does not mean it can never be seen in other habitat-types. Indeed birds such as Pond heron, Redwattled lapwing, Common green bee-eater, Little brown dove, Redvented and Redwhiskered bulbuls, Jungle babbler, Jungle crow, Indian robin and Pied bush chat were seen to be widely distributed in the catchment and were sometimes encountered in other habitats also.

It is seen from the table that out of the total number of 89 species recorded in this zone, the comparatively undisturbed area of the sacred grove appears to harbour less than 10% only. These may be said to indicate avifauna that was once typical of this zone. As biotic influences have eliminated most of the dry deciduous to moist deciduous types of forest, the birds characteristic of these biotopes have disappeared also. As xerophytic conditions are created birds belonging to stony, barren, thorn and scrub types of habitat have invaded this zone. Such species now constitute about 45% of the total avifauna recorded in this zone. These species perhaps indicate the degree of degradation of habitat from an idyllic state dictated solely by environmental conditions. The complete disappearance of birds belonging to moist deciduous biotope may also provide another indication of the degradation of the habitat.

Birds in the II Zone:

Table 3 likewise shows the distribution of birds in the second or middle zone. The table shows that this zone is far richer in birds than the first. The highest number of species are from the habitat, 'trees interspersed with shrubs' followed by those from 'trees' and 'sacred groves'. If species recorded in the sacred grove are to be considered as typical of this zone, their percentage in the total recorded number is 12 only; i.e. species belonging to moist deciduous and semi-evergreen biotopes have been reduced to 12%. Species from dry deciduous and to a lesser extent open, thorn and scrub types of habitat seem to have invaded this zone due to biotic pressures. However, these pressures do not appear to be strong enough to reduce to insignificance the species from moist deciduous and semi-evergreen biotopes. Neither do they seem to be restricted to sacred groves only. Outside sacred groves such species have been recorded from 'trees interspersed with shrubs' and 'trees and village environs'. Indeed the existence of scattered groups of trees, of lush vegetation around villages and of a large sacred grove in this zone appear to have contributed to the maintenance of many species that otherwise would have been eliminated. While the degree of degradation of the habitat in this zone may be gauged by the number of species belonging to more open and drier habitats, the process of degradation itself appears to have been arrested by certain conservation practices of the local people.

Birds in the III Zone:

The third zone again presents a very peculiar picture if its bird-life is examined. Table 4

TABLE 2

DISTRIBUTION OF BIRDS ACCORDING TO HABITAT IN ZONE I IN THE CATCHMENT OF PANSHET DAM

HABITAT TYPES

Aquatic 1	Rocky Plateau 2	Grassy Plateau 3	Thorny Scrub 4	Shrubs & Trees 5	Trees & Village Environs 6	Sacred Groves 7	Seen in Flight 8
Phalacrocorax carbo	*Coturnix coromandelica*	*Bubulcus ibis*	*Perdicula asiatica*	*Accipiter nisus*	*Columba livia*	*Galloperdix spadicea*	*Elanus caeruleus*
Phalacrocorax niger	*Perdicula argoondah*	*Circus macrourus*	*Merops orientalis*	*Butastur teesa*	*Streptopelia decaocto*	*Treron phoenicoptera*	*Milvus migrans govinda*
Tringa ochropus	*Vanellus indicus*	*Francolinus pictus*	*Lanius schach*	*Falco tinnunculus*	*Psittacula krameri*	*Psittacula cyanocephala*	*Gyps indicus*
Tringa hypoleucos	*Streptopelia senegalensis*	*Alauda gulgula*	*Pycnonotus cafer*	*Clamator jacobinus*	*Halcyon smyrnensis*	*Caprimulgus indicus*	*Gyps bengalensis*
Ceryle rudis	*Caprimulgus asiaticus*	*Cisticola juncidis*	*Chrysomma sinense*	*Taccocua leschenaultii*	*Dicrurus adsimilis*	*Megalaima viridis*	*Neophron percnopterus*
Alcedo atthis	*Mirafra erythroptera*	*Anthus similis*	*Turdoides caudatus*	*Lanius vittatus*	*Sturnus pagodarum*	*Tephrodornis pondicerianus*	*Spilornis cheela*
Motacilla maderaspatensis	*Eremopterix grisea*	*Estrilda amandava*	*Turdoides striatus*	*Pycnonotus jocosus*	*Acridotheres tristis*	*Pomatorhinus horsefieldii*	*Apus affinis*
	Ammomanes phoenicurus	*Emberiza buchanani*	*Prinia hodgsonii*	*Prinia socialis*	*Corvus macrorhynchos*	*Alcippe poioicephala*	*Hirundo concolor*
	Galerida malabarica		*Prinia subflava*	*Prinia sylvatica*	*Pericrocotus cinnamomeus*	*Terpsiphone paradisii*	*Hirundo rustica*
	Saxicola torquata		*Sylvia curruca*	*Acrocephalus dumetorum*	*Aegithina tiphia*		*Hirundo smithii*
	Monticola solitarius		*Phylloscopus collybita*	*Turdus merula*	*Anthus trivialis*		*Hirundo daurica*
	Motacilla alba		*Phylloscopus* sp.	*Lonchura punctulata*	*Passer domesticus*		
	Melophus lathami		*Lonchura malabarica*		*Ploceus philippinus*		

TABLE 3

DISTRIBUTION OF BIRDS ACCORDING TO HABITAT IN ZONE II IN THE CATCHMENT OF PANSHET DAM

Aquatic 1	Grassy Plateau 2	Thorny Scrub 3	Shrubs & Trees 4	Trees & Village Environs 5	Sacred Groves 6	Seen in Flight 7
Ardeola grayii	*Bubulcus ibis*	*Turnix suscitator*	*Accipiter badius*	*Amaurornis phoenicurus*	*Spilornis cheela*	*Elanus caeruleus*
Egretta intermedia	*Circus macrourus*	*Streptopelia senegalensis*	*Accipiter nisus*	*Columba livia*	*Chalcophaps indica*	*Pernis ptilorhyncus*
Egretta garzetta	*Coturnix coromandelica*	*Merops orientalis*	*Falco tinnunculus*	*Streptopelia chinensis*	*Otus bakkamoena*	*Spizaetus cirrhatus*
Ciconia episcopus	*Vanellus indicus*	*Lanius schach*	*Perdicula asiatica*	*Psittacula krameri*	*Bubo bubo*	*Hieraaetus pennatus*
Pandion haliaetus	*Upupa epops*	*Pycnonotus cafer*	*Galloperdix spadicea*	*Eudynamis scolopacea*	*Dicrurus leucophaeus*	*Aquila rapax*
Tringa ochropus	*Galerida malabarica*	*Turdoides striatus*	*Treron phoenicoptera*	*Centropus sinensis*	*Sturnus malabaricus*	*Gyps indicus*
Tringa hypoleucos	*Alauda gulgula*	*Prinia subflava*	*Psittacula phoenicoptera*	*Athene brama*	*Pericrocotus flammeus*	*Gyps bengalensis*
Calidris minuta	*Cisticola juncidis*	*Prinia sylvatica*	*Cuculus micropterus*	*Halcyon smyrnensis*	*Hypsipetes madagascari-ensis*	*Falco peregrinus*
Alcedo atthis	*Motacilla alba*	*Phylloscopus collybita*	*Caprimulgus indicus*	*Megalaima haemacephala*	*Pellorneum ruficeps*	*Apus melba*
Myiophonus horsefieldii		*Phylloscopus* sp.	*Megalaima viridis*	*Oriolus oriolus*	*Alcippe poioicephala*	*Apus affinis*
Motacilla cinerea		*Saxicola caprata*	*Lanius vittatus*	*Sturnum pagodarum*	*Culicicapa ceylonensis*	*Hemiprocne longipennis*
Motacilla maderaspatensis		*Saxicoloides fulicata*	*Acridotheres fuscus*	*Corvus macrorhynchos*	*Hypothymis azurea*	*Hirundo rupestris*

2

TABLE 2

DISTRIBUTION OF BIRDS ACCORDING TO HABITAT IN ZONE I IN THE CATCHMENT OF PANSHET DAM

HABITAT TYPES

Aquatic 1	Rocky Plateau 2	Grassy Plateau 3	Thorny Scrub 4	Shrubs & Trees 5	Trees & Village Environs 6	Sacred Groves 7	Seen in Flight 8
Phalacrocorax carbo	*Coturnix coromandelica*	*Bubulcus ibis*	*Perdicula asiatica*	*Accipiter nisus*	*Columba livia*	*Galloperdix spadicea*	*Elanus caeruleus*
Phalacrocorax niger	*Perdicula argoondah*	*Circus macrourus*	*Merops orientalis*	*Butastur teesa*	*Streptopelia decaocto*	*Treron phoenicoptera*	*Milvus migrans govinda*
Tringa ochropus	*Vanellus indicus*	*Francolinus pictus*	*Lanius schach*	*Falco tinnunculus*	*Psittacula krameri*	*Psittacula cyanocephala*	*Gyps indicus*
Tringa hypoleucos	*Streptopelia senegalensis*	*Alauda gulgula*	*Pycnonotus cafer*	*Clamator jacobinus*	*Halcyon smyrnensis*	*Caprimulgus indicus*	*Gyps bengalensis*
Ceryle rudis	*Caprimulgus asiaticus*	*Cisticola juncidis*	*Chrysomma sinense*	*Taccocua leschenaultii*	*Dicrurus adsimilis*	*Megalaima viridis*	*Neophron percnopterus*
Alcedo atthis	*Mirafra erythroptera*	*Anthus similis*	*Turdoides caudatus*	*Lanius vittatus*	*Sturnus pagodarum*	*Tephrodornis pondicerianus*	*Spilornis cheela*
Motacilla maderaspatensis	*Eremopterix grisea*	*Estrilda amandava*	*Turdoides striatus*	*Pycnonotus jocosus*	*Acridotheres tristis*	*Pomatorhinus horsefieldii*	*Apus affinis*
	Ammomanes phoenicurus	*Emberiza buchanani*	*Prinia hodgsonii*	*Prinia socialis*	*Corvus macrorhynchos*	*Alcippe poioicephala*	*Hirundo concolor*
	Galerida malabarica		*Prinia subflava*	*Prinia sylvatica*	*Pericrocotus cinnamomeus*	*Terpsiphone paradisii*	*Hirundo rustica*
	Saxicola torquata		*Sylvia curruca*	*Acrocephalus dumetorum*	*Aegithina tiphia*		*Hirundo smithii*
	Monticola solitarius		*Phylloscopus collybita*	*Turdus merula*	*Anthus trivialis*		*Hirundo daurica*
	Motacilla alba		*Phylloscopus* sp.	*Lonchura punctulata*	*Passer domesticus*		
	Melophus lathami		*Lonchura malabarica*		*Ploceus philippinus*		

TABLE 3

DISTRIBUTION OF BIRDS ACCORDING TO HABITAT IN ZONE II IN THE CATCHMENT OF PANSHET DAM

Aquatic 1	Grassy Plateau 2	Thorny Scrub 3	Shrubs & Trees 4	Trees & Village Environs 5	Sacred Groves 6	Seen in Flight 7
Ardeola grayii	*Bubulcus ibis*	*Turnix suscitator*	*Accipiter badius*	*Amaurornis phoenicurus*	*Spilornis cheela*	*Elanus caeruleus*
Egretta intermedia	*Circus macrourus*	*Streptopelia senegalensis*	*Accipiter nisus*	*Columba livia*	*Chalcophaps indica*	*Pernis ptilorhyncus*
Egretta garzetta	*Coturnix coromandelica*	*Merops orientalis*	*Falco tinnunculus*	*Streptopelia chinensis*	*Otus bakkamoena*	*Spizaetus cirrhatus*
Ciconia episcopus	*Vanellus indicus*	*Lanius schach*	*Perdicula asiatica*	*Psittacula krameri*	*Bubo bubo*	*Hieraaetus pennatus*
Pandion haliaetus	*Upupa epops*	*Pycnonotus cafer*	*Galloperdix spadicea*	*Eudynamys scolopacea*	*Dicrurus leucophaeus*	*Aquila rapax*
Tringa ochropus	*Galerida malabarica*	*Turdoides striatus*	*Treron phoenicoptera*	*Centropus sinensis*	*Sturnus malabaricus*	*Gyps indicus*
Tringa hypoleucos	*Alauda gulgula*	*Prinia subflava*	*Psittacula phoenicoptera*	*Athene brama*	*Pericrocotus flammeus*	*Gyps bengalensis*
Calidris minuta	*Cisticola juncidis*	*Prinia sylvatica*	*Cuculus micropterus*	*Halcyon smyrnensis*	*Hypsipetes madagascariensis*	*Falco peregrinus*
Alcedo atthis	*Motacilla alba*	*Phylloscopus collybita*	*Caprimulgus indicus*	*Megalaima haemacephala*	*Pellorneum ruficeps*	*Apus melba*
Myiophonus horsefieldii		*Phylloscopus* sp.	*Megalaima viridis*	*Oriolus oriolus*	*Alcippe poioicephala*	*Apus affinis*
Motacilla cinerea		*Saxicola caprata*	*Lanius vittatus*	*Sturnus pagodarum*	*Culicicapa ceylonensis*	*Hemiprocne longipennis*
Motacilla maderaspatensis		*Saxicoloides fulicata*	*Acridotheres fuscus*	*Corvus macrorhynchos*	*Hypothymis azurea*	*Hirundo rupestris*

TABLE 3 (contd.)

Aquatic 1	Grassy Plateau 2	Thorny Scrub 3	Shrubs & Trees 4	Trees & Village Environs 5	Sacred Groves 6	Seen in Flight 7
		Nectarinia asiatica	*Aegithina tiphia*	*Pomatorhinus horsefieldii*	*Monticola cinclorhynchus*	*Hirundo concolor*
		Petronia xanthocollis	*Tephrodornis pondicerianus*	*Muscicapa parva*	*Zoothera citrina*	*Hirundo smithii*
		Ploceus philippinus	*Coracina melanoptera*	*Muscicapa pallipes*	*Anthus trivialis*	
			Pericrocotus cinnamomeus	*Muscicapa tickelliae*		
			Pycnonotus jocosus	*Rhipidura aureola*		
			Pycnonotus luteolus	*Orthotomus sutorius*		
			Turdoides subrufus	*Copsychus saularis*		
			Muscicapa thalassina	*Phoenicurus ochruros*		
			Acrocephalus dumetorum	*Parus major*		
			Turdus merula	*Parus xanthogenys*		
				Dicaeum agile		
				Dicaeum erythrorhynchos		
				Zosterops palpebrosa		
				Lonchura punctulata		

TABLE 3 (contd.)

Aquatic 1	Grassy Plateau 2	Thorny Scrub 3	Shrubs & Trees 4	Trees & Village Environs 5	Sacred Groves 6	Seen in Flight 7
		Nectarinia asiatica	*Aegithina tiphia*	*Pomatorhinus horsefieldii*	*Monticola cinclorhynchus*	*Hirundo concolor*
		Petronia xanthocollis	*Tephrodornis pondicerianus*	*Muscicapa parva*	*Zoothera citrina*	*Hirundo smithii*
		Ploceus philippinus	*Coracina melanoptera*	*Muscicapa pallipes*	*Anthus trivialis*	
			Pericrocotus cinnamomeus	*Muscicapa tickelliae*		
			Pycnonotus jocosus	*Rhipidura aureola*		
			Pycnonotus luteolus	*Orthotomus sutorius*		
			Turdoides subrufus	*Copsychus saularis*		
			Muscicapa thalassina	*Phoenicurus ochruros*		
			Acrocephalus dumetorum	*Parus major*		
			Turdus merula	*Parus xanthogenys*		
				Dicaeum agile		
				Dicaeum erythrorhynchos		
				Zosterops palpebrosa		
				Lonchura punctulata		

Table 4

Distribution of birds according to habitat in zone III in the catchment of Panshet Dam

HABITAT TYPES

Aquatic 1	Thorny Scrub 2	Shrubs & Trees 3	Trees & Villages Environs 4	Sacred Groves 5	Seen in Flight 6
Ardeola grayii	*Perdicula asiatica*	*Accipiter badius*	*Bubulcus ibis*	*Gallus sonneratii*	*Elanus caeruleus*
Anas poecilorhyncha	*Vanellus indicus*	*Accipiter nisus*	*Amaurornis phoenicurus*	*Chalcophaps indica*	*Pernis ptilorhyncus*
Larus ridibundus	*Streptopelia senegalensis*	*Spilornis cheela*	*Columba livia*	*Otus bakkamoena*	*Spizaetus cirrhatus*
Alcedo atthis	*Merops orientalis*	*Falco tinnunculus*	*Streptopelia orientalis*	*Bubo zeylonensis*	*Ictinaetus malayensis*
Myiophonus horsfieldii	*Lanius schach*	*Galloperdix spadicea*	*Oriolus oriolus*	*Strix leptogrammica*	*Gyps indicus*
Motacilla cinerea	*Pycnonotus jocosus*	*Centropus sinensis*	*Sturnus pagodarum*	*Dicrurus leucophueus*	*Gyps bengalensis*
Motacilla maderaspatensis	*Pycnonotus cafer*	*Caprimulgus indicus*	*Acridotheres fuscus*	*Sturnus malabaricus*	*Falco peregrinus*
	Turdoides subrufus	*Megalaima viridis*	*Corvus macrorhynchos*	*Pericrocotus flammeus*	*Apus melba*
	Turdoides striatus	*Lanius vittatus*	*Alcippe poioicephala*	*Hypsipetes indicus*	*Hemiprocne longipennis*
	Phylloscopus collybita	*Coracina melanoptera*	*Muscicapa parva*	*Pellorneum ruficeps*	*Hirundo rupestris*
	Phylloscopus sp.	*Pomatorhinus horsfieldii*	*Muscicapa pallipes*	*Hypsipetes madagascari-ensis*	*Hirundo concolor*
	Saxicola caprata		*Muscicapa tickelliae*	*Culicicapa ceylonensis*	
	Saxicoloides fulicata	*Turdus merula*	*Rhipidura aureola*	*Terpsiphone paradisii*	
	Nectarinia asiatica	*Anthus trivialis*	*Orthotomus sutorius*	*Hypothymis azurea*	
		Petronia xanthocollis	*Erithacus brunneus*	*Monticola cinclorhynchus*	
		Carpodacus erythrinus	*Copsychus saularis*	*Zoothera citrina*	
			Parus xanthogenys	*Citta castanea*	
			Dicaeum agile	*Nectarinia minima*	
			Dicaeum erythrorhynchos	*Aethopyga siparaja*	
			Zosterops palpebrosa		

gives the distribution according to habitat in this zone.

It may be recalled that the average annual rainfall in this zone ranges between 6001 to 9000 mm. As such the zone should be clothed with semi-evergreen to evergreen forest. But biotic influences have reduced the vegetation to scattered trees and bushes. The sacred groves near villages Tekpowale and Dapsar are not as large as those near Ambegaon Khurd and Mangaon and they are the only masses of vegetation that now remain in this zone. Also some reserve forest area near the source of the river Ambi still remains more or less wooded. The number of species of birds recorded in this zone is far less than the number in the middle zone and is even marginally lower than the number from the first zone. Out of the total number of species recorded in this zone only 3 namely, Redwattled lapwing, Little brown dove and Indian robin may be properly said to represent thorn and scrub type of habitat. In spite of widespread availability of shrubbery species from open and scrub type of biotope do not seem to be successful in colonising this zone. Species representing dry deciduous biotope also are less numerous than in the middle zone. While there are 43 species which may be said to represent moist deciduous to semi-evergreen biotope, species representing evergreen forest appear to be totally absent. Species like Nilgiri Wood Pigeon (*Columba elphinstonii*), Greyfronted Green Pigeon (*Treron pompadora*), Bluewinged Parakeet (*Psittacula columboides*) and Shama (*Copsychus malabaricus*) which occur in other protected areas in these hills, have disappeared from the catchment. Out of these 43 species 21 were found to be restricted to sacred groves only. They are likely to disappear if these groves are further disturbed. The role of large areas of undisturbed indigeneous vegetation such as sacred groves in the maintenance of avifauna is thus again highlighted. The peculiar weather conditions prevailing in this zone may perhaps make it unfit for colonization by species from drier habitats.

It therefore, appears that biotic influence has disturbed this sector to a greater extent than any other sector. The peculiar weather conditions in this zone, dominated as they are by the Western Ghats which are instrumental in bringing torrential rains into this area, have probably rendered the character of vegetation and bird life a specialised one. Only a restricted number of bird families appear to be able to adapt to these conditions and their food and habitat requirements may be typical. They quickly succumb if these are interfered with and other bird species, though their needs are less specialized, seem not to be very successful in colonising this area. The hills in this zone therefore, represent a very fragile eco-system which needs strict protection if its characteristic vegetation and bird life are to survive.

It may not be inappropriate to recapitulate here the main points that are made out in the above analysis:

1. In a particular area the extent to which the character of bird life differs from the one indicated by environmental conditions may point to the degree of deterioration of the habitat.

2. In certain areas climatic conditions and consequently the character of vegetation may be so specialised as to render biotic interference doubly destructive. On the one hand, biotic interference leads to elimination of certain specialized bird species through destruction of their habitat, on the

other, the peculiar climatic conditions prevailing in the area may prevent the invasion by other bird species belonging to different biotopes. Such regions thus deserve a greater degree of protection to preserve the peculiar character of their avifauna. Here the character of bird life may provide an answer to the question why a particular region needs special protection.

3. Examination of the character of bird life of a particular region may bring out the importance of certain age-old practices that contribute to conservation of nature. Importance of indigenous vegetation in the maintenance of avifaunal diversity and richness is also brought out through the above analysis.

Conservation Implications:

The major destructive factor in these hills appears to be the practice of shifting cultivation. River valley projects in these hills have only forced the inhabitants to resort to such cultivation with a greater intensity. The sooner they are given alternative sources of income the better for hill flora and fauna.

In these hills sacred groves appear to be pools or islands of biological diversity in the midst of increasing impoverishment of the habitat. They should be carefully protected. Certain groves are being progressively destroyed due to erosion of religious sentiments and economic pressure; at some sites only a dilapidated temple under a large tree provides clue to the existence of a sacred grove. Such groves need to be identified by reestablishing their former boundaries and the whole area should be given protection to rehabilitate it.

The ridges with very high rainfall with their specialized flora and fauna need complete protection. These ridges also give birth to a number of our famous rivers that flow eastward and benefit millions who live on their banks in the plains. Complete protection will make the source regions of our important rivers inviolate. All these ridges should as such form part of a vast national park or protective zone that should run north-south along the entire length of the Western Ghats.

In the end, some general remarks regarding birds of deforested hills may not be out of place. A total of about 160 species of birds in an area of about 121 sq. km may be said to indicate a general paucity of birds. No comparable figures are available though it may be pertinent to note that areawise the number of species is far less than the number recorded in Pune city! (Gole 1980). If aquatic birds are excluded the proportion of bird species that feed on the ground and in low bushes appears to be high and reflects perhaps the scarcity of trees in these hills. In particular the complete absence of woodpeckers and hornbills is striking and perhaps reflects the lack of old mature trees in the hills. The variety of birds of prey may also be noted. It is probable that the widespread practice of shifting cultivation may invite rodents on a large scale which in turn attract birds of prey. Cultivators when asked, uniformly complained about the menace of rodents such as mice, rats and hares, and fields when examined at random for the presence of rodent burrows, revealed it not insubstantially. However, only the Crested serpent eagle was found to be nesting in these hills. Others are probably transients and cannot nest as suitable nesting trees are scarce. The paucity of game birds such as ducks and waders, partridges and junglefowls and pigeons and doves may also be noted. This denies local residents an important source of protein for which perhaps

they themselves are to blame. But it may also be added that with better management of the habitat it is possible to rehabilitate these species. Lastly, it may be interesting to note that commensals of man such as House crow, House sparrow and Common myna have not as yet penetrated these hills to any appreciable extent and their general absence provides a welcome change to the trekkers and observers of bird life that care to visit our hills.

ACKNOWLEDGEMENTS

This study formed a part of a wider study involving a status survey of plant and animal life of the Panshet catchment in order to prepare an eco-development plan for the area. The study was sponsored by Department of Environment, Government of India. Their assistance is gratefully acknowledged.

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THE BUTTERFLIES OF THE NILGIRI MOUNTAINS OF SOUTHERN INDIA (LEPIDOPTERA: RHOPALOCERA)[1]

TORBEN B. LARSEN[2]

[*Continued from Vol. 84*(1): 54]

LYCAENIDAE

MILETINAE

050. **Spalgis epeus epeus** Westwood

The APEFLY, so called because the pupa looks like a miniature monkey head, is an unusual little butterfly that is the only representative of its subfamily in South India. The underside is greyish brown with a dark irroration that differs from the pattern of any other species in the area. It is found mainly in lowland evergreen formations, though it should occur also in the denser mixed deciduous forest. I do have a definite record from near Kotagiri (1900 m) from May 1957 which is most unusual; the specimen is still in my possession. The flight is rather fast and erratic for such a small butterfly, but it usually does not fly high. It seems to be scarce in the Nilgiris. Wynter-Blyth caught three at Kallar from where I have one and I have collected only half a dozen or so at various points on the Nadgani Ghat. The larva is unusual since it feeds exclusively on Coccidae (mealy bugs), the only wholly carnivorous butterfly in the Nilgiris. It occurs in Sri Lanka, in suitable jungles of peninsular India, and from Kumaon to practically the entire Oriental region. One or two species of *Spalgis* also occur in Africa.

[1] Accepted January 1987.

[2] Snoghoj alle 29C, 2770 Kastrup, Denmark.

POLYOMMATINAE

POLYOMMATINI

051. **Castalius rosimon rosimon** Fabricius

The COMMON PIERROT is found in most types of country up to about 1400 m, rarely higher, provided open forest is present. It spends its time fluttering about *Zizyphus* shrubs which are the larval food plants, but it visits flowers readily and also comes to damp patches during the dry season or on exceptionally hot days. Dead insects and bird droppings are also an attractant. The genus is monobasic and the many other species which have been allotted to it are now transferred to resurrected genera, and in the case of the African species to *Tuxentius* Larsen (1982). The species is found throughout the Oriental region.

052. **Caleta caleta decidia** Hewitson
(*Castalius caleta*)

The ANGLED PIERROT is a moderately common butterfly whose black upperside with the prominent white discal band on all four wings makes it unmistakable in the Nilgiris. The main habitat is open evergreen forest, but it may be found also in mixed deciduous and in subtropical evergreen forest. It is, however, a very poor coloniser of disturbed habitats. It is one

of the most frequent visitors to mudpuddles and it is quite inordinately fond of bird droppings. Wynter-Blyth found it common to 8000 ft, but that would be quite exceptional in my experience. The distribution covers Sri Lanka, suitable localities in peninsular India, Orissa, Bengal, from whence east to Indo-China and the Philippines. It is replaced by very similar species in Sundaland proper.

053. **Discolampa ethion vavasanus** Fruhstorfer (*Castalius ethion*)

The BANDED BLUE PIERROT is a delightful little butterfly, the only one in South India to have a defined white band on a shiny blue background. It is not rare in lowland evergreen forest, being a bit scarcer in dense mixed deciduous forest, and only just penetrating the lower levels of the subtropical evergreen forests. It never ventures away from forest. It comes less frequently to water than do the two preceding species, and it seems disinterested in bird droppings. It is very fond of sweat, though, and often settled on my shirt or shoulder bag both in India and in Thailand. The flight is very weak and the butterfly is rather unobtrusive. It is found in Sri Lanka and in South India, recurring from Assam to practically the entire Oriental region and New Guinea.

054. **Tarucus ananda** de Nicéville

The DARK PIERROT is quite a unique little butterfly and I cannot help wondering whether it does not need a genus of its own. It is very scarce in the Nilgiris. In September 1883 Hampson took a long series on the northern slopes, presumably in the Ouchterlony Valley area (5000 ft). Wynter-Blyth failed to procure it. I have taken a few at water in the forests below Glenburn on two occasions only (12.vi and 15.viii). Near Karkala in Kanara I found a tall jungle tree which was infested with this butterfly. Every second or third leaf had one or more larvae and hundreds of battered imagines were flying about. A vicious small ant was in agitated attendance. The tree was a big-leaved evergreen and successive generations of larvae had removed more than 25% of all the chlorophyl, carefully avoiding damage to the leaf membranes. Seriously damaged leaves were eaten to the point that they resemble the *Peepal* leaves from which painted souvenirs are made in northern India. It is amazing that such a tiny butterfly could do so much damage. The species is found only in southern India, and then again from Nepal east to Burma.

055. **Tarucus nara** Kollar

(*T. nara, T. extricatus, & T. alteratus*)

Despite the fact that the male genitalia always give a firm determination in the Blue Pierrot group, they have always been the victims of great confusion. The STRIPED PIERROT is a common Indian butterfly of the drier tracts and it is quite frequently met with at the foot of the northern and southern slopes of the Nilgiris, nearly always where *Zizyphus nummularia*, the larval food plant, grows. Very occasionally one may find *Castalius rosimon* on the same plants, though their ranges do not overlap much. The *Tarucus* are essentially eremic butterflies of the subdesert zone that stretches from Mauritania through Arabia to NW India. The present species is endemic to India and Sri Lanka.

056. **Tarucus callinara** Butler

The SPOTTED PIERROT is very similar to the preceding one, but there is a clear tendency that the black markings on the underside have a more macular shape. This is especially true for the submarginal series. The only records of this species that I have from anywhere in southern India are my own from Masinagudi

(9.vi and 18.x). Evans (1955) does not mention it from much south of Madhya Pradesh where I have found it quite widespread. It is perhaps not surprising that other firm records are not available since older literature is confused about the genus. Hampson does describe specimens that sound as if they are genuinely *T. callinara.* In habits they do not differ from the preceding species. The distribution covers the area from India to Burma, and it has recently been found also in Thailand (*pers. obs. unpublished,* from Kanchanaburi).

057. **Syntarucus plinius** Fabricius

This is the only Oriental species of an essentially African genus and it appears to be phylogenetically closest to *Syntarucus babaoulti* Stempffer, based on genital morphology, the only certain way of telling species in the genus apart. The species is common more or less everywhere, though essentially tied to the open and dried biotopes. It is also somewhat periodical and may go missing for months in places where it was previously common. It does not penetrate the densest wet evergreen forests or the plateau *sholas,* but otherwise it may turn up anywhere. It has a wide range of larval food plants but I have always found *Plumbago zeylonica* to be exceptionally attractive to this and to some of the African species. The adult butterfly visits flowers and wet patches. It covers most of the Oriental region, but seems to be absent from Malaysia.

058. **Azanus ubaldus** Cramer

The BRIGHT BABUL BLUE is an Afrotropical butterfly that has penetrated the Indian subcontinent and Sri Lanka. Hampson thought it 'rather rare, 1000 to 7000 ft'. Wynter-Blyth found it common on the southern slopes to the very top of the hills. I have seen it frequently at water on both the northern and the southern slopes, especially during the dry season, but only at low levels. The species is a known migrant and probably of somewhat erratic occurrence. It may also be met on flowering *Acacia* in some numbers. No one seems to have come across the rather similar *Azanus uranus* Butler in the Nilgiris. The two fly together in Delhi and the latter is definitely a valid species and not a form of *A. ubaldus* (Larsen 1987a). It ought to occur in the area. *A. ubaldus* is found throughout the drier parts of Sri Lanka and India, the main range encompassing all of Arabia and Africa.

059. **Azanus jesous** Guérin-Méneville

The AFRICAN BABUL BLUE is not common in the Nilgiris. Hampson thought it rare at low levels. Wynter-Blyth found it common at Kallar in November, 1941 but did not otherwise see it. I have found moderate numbers at Masinagudi on various occasions (esp. 9.vi and 18.x), collected a few at Kallar (23.v) and found it common at Ronningtown (25.v). It would appear to share with many other migrants a degree of unpredictability. Most of my specimens have been seen at damp patches with a dozen or so other Lycaenids, but it may also be caught on the flowers of *Acacia.* The distribution covers most of Sri Lanka, India, Arabia and Africa, with slight penetration of the hotter parts of the Mediterranean.

060. **Everes lacturnus syntala** Cantlie
(*Everes parrhasius*)

The INDIAN CUPID (a poor common name given the vast range of the species) is not rare at lower levels in the Nilgiris, penetrating also the subtropical zone. It comes readily to flowers and water and is most frequently seen during the dry season. The species appears to be somewhat migratory. It was common in a Delhi Park during 1984, from where it had never been recorded, but was missing from this

locality in 1985 (Larsen 1987a). It is mainly found in the drier lowland formations, including the savannas at Masinagudi. The genus is essentially Palaearctic, but *E. lacturnus* covers the entire Oriental region, New Guinea and Australia.

061. **Udara akasa mavisa** Fruhstorfer
(*Lycaenopsis akasa*)

In the *Lycaenopsis* group of genera I follow the recent monumental work of Eliot & Kawazoe (1983), though possibly their generic level splitting is somewhat excessive. The WHITE HEDGE BLUE is a common little butterfly everywhere on the plateau, even some distance from forest. Though tiny and weak in flight they manage to cover considerable distances. The species descends through the dense evergreen forests of the subtropical zone and may be found at quite low levels in wet evergreen forest such as at Nadgani. Mostly it is seen patrolling tirelessly along forest roads or edges, often stopping to feed from flowers. I never saw it at water. It is also found in Sri Lanka where it is quite rare and then recurs in the montane zones of Malaysia and Vietnam, a very strongly disjunct pattern for such a small butterfly. It extends further to Sumatra, Java and the Lesser Sunda Islands.

062. **Acytolepis puspa felderi** Toxopeus
(*Lycaenopsis puspa*)

The COMMON HEDGE BLUE male has a white disc otherwise only found in the very similar *Celatoxia albidisca.* The former is a low level species found in wet forest to the mixed deciduous, being unable to survive in thorn forest or agricultural lands. The latter is essentially montane and the two have only the most fleeting zone of overlap in parts of the subtropical zone and are rarely found together. *A. puspa* is a more robust insect with less precise black markings on the underside. It is an avid mudpuddler that also visits bird droppings and fresh cowpats. I have rarely encountered any on flowers. It is found in forested country from Sri Lanka, through India to most of the Oriental region.

063. **Acytolepis lilacea lilacea** Hampson
(*Lycaenopsis lilacea*)

HAMPSON'S HEDGE BLUE is a rare little butterfly which is found in Sri Lanka and South India (Palnis, Nilgiris and Coorg). It occurs everywhere with *Acytolepis puspa* in lowland forest, just penetrating the subtropical zone, but it is very much scarcer. I have specimens from Nadgani, Kotagiri Ghat and Glenburn, while Wynter-Blyth took it at Kallar. On the wing it is difficult to tell from *A. puspa* though the male lacks any white on the disc of the forewings. The broad black border of the forewing upperside will serve to distinguish it from *Celastrina lavendularis.* Apart from the populations of South India and Sri Lanka the species is found in parts of Indo-China and Burma. Till quite recently it was considered endemic to southern India and Sri Lanka.

064. **Celatoxia albidisca** Moore
(*Lycaenopsis albidisca*)

The WHITEDISC HEDGE BLUE is endemic to the hills of southern India where it is common along the edges of and in clearings within the typical montane *sholas.* It may descend to the subtropical zone but is then very much scarcer. Occasional wandering specimens may be seen flying in open country. Inside *sholas* the butterflies are often seen flying high among the tangled crowns, but not infrequently it will come to flowing water, even on a cool day. I have found this to be the case for certain other montane species such as *Parantica nilgiriensis,* the Sumatran *Euploea martini* and many montane butterflies in Papua New Guinea. It is rarely seen on flowers.

065. **Celastrina lavendularis lavendularis** Moore
(*Lycaenopsis lavendularis*)

The PLAIN HEDGE BLUE lacks the white discs of the previous montane species. According to Wynter-Blyth it is a common species above 1500 m, especially in montane *sholas*, but I never met with it. In all likelihood it is at the trough of a cyclical decline. Col. Eliot recently told me that such cyclical variation occurred in some Malaysian montane members of the group. The species is found practically throughout the Oriental region.

066. **Neopithecops zalmora dharma** Moore

The QUAKER is a characteristic little butterfly that is common in the lowland evergreen forests, penetrating the mixed deciduous and the subtropical evergreen, and showing some ability to colonise agricultural land if *Glycosmis*, one of the rutaceous larval food plants, is present in quantity. It may be very common in the agricultural area at Kallar. It must be one of the weakest butterflies on the wing, fluttering helplessly about in low vegetation. The black upperside and the white underside lead to a peculiar flickering flight profile. Flowers do not seem to hold much attraction for the species, but it avidly visits damp patches. The distribution covers Sri Lanka, the Western and Eastern Ghats, and then from Kumaon east to practically the whole of the Oriental region.

067. **Megisba malaya twaithesi** Moore

The MALAYAN is a species of dense lowland evergreen forest that is surprisingly rare in the Nilgiris. Wynter-Blyth caught only one, at Nadgani. I have taken three in this locality in July, September and October. I have single males from the Glenburn area from 4.vii and 1.x. The South Indian and Sri Lankan subspecies is untailed. The species is tailed in most of the Oriental region, but untailed forms recur towards the Papuan subregion. It is an avid mudpuddler, being partial also to bird droppings, otter dung and fresh cowpats. The distribution covers practically the entire Oriental region.

068. **Zizeeria maha ossa** Swinhoe

The PALE GRASS BLUE is generally by far the most common of the four Grass Blues in South India and may be found practically anywhere, even on paths in primary wet evergreen forest. It is often abundant in tea and coffee plantations because one of the larval food plants, *Oxalis*, seems to do well here despite the heavy application of weedicides and pesticides. It is found in India and Sri Lanka, extending east to Hong Kong and the Philippines, but not southeast to the core of the Oriental region.

069. **Zizeeria karsandra karsandra** Moore

The DARK GRASS BLUE is scarcer in the Nilgiris than it is in many other parts of India, but localised colonies may occur practically anywhere in the area. Most of my own records are from low levels, but Wynter-Blyth recorded it from as high as 8000 ft. This tiny insect has a wholly disproportionate range, being found from Australia to Algeria where it merges with the African vicariant, *Z. knysna* Trimen.

070. **Zizina otis decreta** Butler
(*Zizeeria otis*)

The LESSER GRASS BLUE needs collecting in order to tell it apart from *Z. karsandra* with complete certainty, and I have not been diligent enough in so doing. Wynter-Blyth records it from up to 2000 m, but my own highest records are from about 1500 m. It is an unobtrusive little butterfly rarely flying more than a few centimetres above the ground. Like

the other Grass Blues it is fond of feeding from the flowers of the *Tridax* weed. There are three sister species in this complex which probably demand a modern review: *Z. otis* throughout the Oriental region; *Z. labradus* Godart in the Australian subregion; and *Z. antanossa* Mabille throughout Africa.

071. **Zizula hylax hylax** Fabricius
(*Zizeeria gaika*)

The TINY GRASS BLUE is very variable in size. Small specimens vie with *Freyeria trochylus putli* for the title of the smallest Indian butterfly, while large specimens are often larger than the other Grass Blues. It is worth mentioning that when at rest the butterfly often waggles its wings from side to side in a way that I have not seen in any other Lycaenid; the same behaviour has been observed in Arabia. The species may be found anywhere in the Nilgiris and may be locally very common. Wynter-Blyth considered it to be mainly a low-level species that was scarce on the lower plateau. On 20.v I found it to be very common on dry, open grassland surrounding the Mukurti dam. Indeed, the ecological tolerance and the geographic distribution of this tiny insect is truly amazing. The larval food stuffs are many, some of which highly unusual for the subfamily. It is found throughout Africa and Arabia, from India throughout the Oriental region, and then through New Guinea to the New Hebrides.

072. **Chilades laius laius** Cramer

The LIME BLUE is fairly common at low levels in all types of country, but I have never seen it in abundance. For long periods it may be missing in areas where it used to be common. The seasonal difference is very considerable, but I did not find any very good correlation between the occurrence of these forms and actual weather conditions. The species visits both flowers and damp patches in the company of other Lycaenids and is not easy to identify on the wing. The larvae feed on the young shoots of *Citrus* and perhaps other rutaceous plants. This is so unusual that I was inclined to think it more likely that the larvae were carnivorous, but I found them on fresh *Citrus* at the government fruit garden at Kallar. The range covers the northern parts of the Oriental region from Sri Lanka to the Philippines but not Sundaland proper.

073. **Chilades parrhasius** Fabricius
(*Euchrysops contracta* & *E. minuta*)

The SMALL CUPID has had an unfortunate nomenclatural and taxonomic existence, having been quite wrongly placed in the genus *Euchrysops* and confused in name with the species now known as *Everes lacturnus.* The confusion may not be over. Nekrutenko (1984) erected the new genus *Lachides* for among others this species and retrieves the name *contracta.* The paper is in Russian and I have still not been able to check personally. The butterfly is the one linked to the very driest tracts; it is one of the most common butterflies in Delhi. My only Nilgiri records are from Masinagudi and Ronningtown, just the type of localities where it was to be expected. It is fond of flowers and comes freely to damp patches. The distribution covers the Indian subcontinent, parts of Afghanistan and southern Russia, Iran and the Arabian peninsula.

074. **Chilades pandava pandava** Horsfield
(*Euchrysops pandava*)

The PLAINS CUPID is rather seasonal and quite erratic of occurrence, though it is often common in the wetter lowland forest tracts. There is, hardly any overlap between this species and the preceding one. I have met with it at Kallar, where it is intermittent, and at the lower end of the

Nadgani Ghat where it may be very common indeed. While not being averse to joining in the normal communal mudpuddling assemblages, the species often forms large, dense assemblies consisting exclusively of this species, often in shady places. It is more attracted to foul substances than most species of its group. The distribution is from Sri Lanka to Sundaland.

075. **Freyeria trochylus putli** Kollar (*Zizeeria putli*)

The GRASS JEWEL shares with *Zizula hylax* the distinction of being the smallest Indian butterfly. It is found in open places practically throughout the Nilgiris though it is essentially a dry zone species. It is rather local, very easily overlooked, and probably under reported. With one exception all specimens I have seen match ssp. *putli*: it differs from the nominate subspecies in being darker, usually having more elongated wings, lacking the red anal spots of the hindwing upperside, and in having one or two extra silver-centered black spots along the hindwing underside margin. However, a single large specimen from as improbable a place as the Nadgani Ghat in all respects matches the nominate form. Despite much searching no more could be found in the area. The range is grossly at odds with the size of the butterfly and somewhat enigmatic. It occurs throughout Africa, in the eastern Mediterranean and much of the Middle East to Pakistan and NW India. Ssp. *putli* covers the Indian subcontinent and Sri Lanka, very selected parts of the Oriental region, parts of New Guinea and northeastern Australia.

076. **Euchrysops cnejus cnejus** Fabricius

The GRAM BLUE is a dry zone butterfly that is an effective coloniser of agricultural lands where it is usually more common than in natural habitats. It may be found practically anywhere in the Nilgiris, though it tends to avoid the densest lowland evergreen forests. It was one of the few butterflies actually resident at my Kotagiri compound. It is fond of flowers and comes readily to water. Its habits are unexceptional. The distribution covers the whole of the Oriental region, extending to Australia and deep into the Pacific. Eliot (1978) repeats the old records from Aden which are due to taxonomic and nomenclatural mix-ups with the African *E. osiris*.

077. **Catochrysops strabo strabo** Fabricius

The FORGET-ME-NOT is not rare at low levels in the Nilgiris flying mainly along roadsides and visiting flowers and damp patches. It seems to be at its most common during the dry season. In behaviour it is very much like the other members of the subfamily in the genera *Euchrysops* and *Chilades*. The distribution covers practically the entire Oriental region. There is an additional species in Sri Lanka in the form of *Catochrysops panormus lithargyria* Moore which has a somewhat lighter hue. This species also occurs in Asia proper and its absence from South India is puzzling. It would be well worth keeping a look out for it. However, Tite (1959) does not mention it, and there is certainly no South Indian material in the British Museum (Natural History).

078. **Lampides boeticus** Linné

The PEA BLUE (the English name, the Long-Tailed Blue, is quite unsuitable to Indian conditions) is found everywhere, at

all levels, most of the year. It is not, however, invariably as common as is often suggested, neither in the Nilgiris, nor elsewhere in India. Its frequency is probably mediated in part by migration, and I have seen small numbers as part of the October 1986 migration in Kotagiri. When the exotic *Cytisus* and *Genista* bloom on the Ooty downs the butterfly may be phenomenally common. It comes to flowers and occasionally to water. The larval food plants are many and varied, and it is sometimes a real pest on cultivated peas and beans. It is found right through the tropics of the old world, penetrating well into the Palaearctic region during summer, reaching England regularly but in small numbers.

079. **Jamides bochus bochus** Cramer

The DARK CERULEAN is an unmistakable butterfly. The blue of the male upperside is more intense than possibly in some Neotropical *Morpho*. In flight it looks like a series of metallic blue flashes. It is widely distributed below the plateau level except in the very driest tracts, but since it is a persistent migrant, it may be found even there. In the late 1950ies I saw a definite directional migration towards the east at Kotagiri. It visits flowers intermittently, usually those of its very varied leguminose larval food plants. Damp patches are visited only sporadically. Much of the time is taken up with simply sitting on leaves in a shady spot. The flight is faster, higher and more erratic than in the two following species of *Jamides*.

080. **Jamides celeno aelianus** Fabricius

The COMMON CERULEAN is one of the most common butterflies of the lowland tracts in the Nilgiris, from the driest to the wettest, but most happy where there is a plentiful supply of the main larval food plant, *Pongamia glabra*. In the savanna forests it is mainly found along streams. It becomes progressively scarcer as one moves up through the subtropical zone, and it is a rare visitor to the actual plateau where Wynter-Blyth recorded it as high as 7500 ft. The larvae are not gregarious but often so crowded that several are found on each leaf of the food plant. They are avidly attended by ants. Both sexes visit flowers and males will come to water, but not with any obsessional zeal like so many other Lycaenids. The flight is weak and fluttering and it is often possible to mistake the species for something more interesting than it is. The distribution covers the whole of the Oriental region to New Guinea.

081. **Jamides alecto alocina** Swinhoe

The METALLIC CERULEAN flies with the Common Cerulean but only in the wetter lowland tracts where its somewhat unusual food plant, cardamom, grows. It has been recorded as a serious pest of this valuable crop, but this does not seem to be a problem in the Nilgiris according to many planters with whom I spoke. The species is quite rare in the Nilgiris and I only obtained three at Glenburn, Mukkali and in the Wynaad. I saw well over a dozen in evergreen forest in the Biligiriranga Mountains during one day. There is normally no difficulty in telling the two species apart even on the wing. *J. alecto* is much darker and much more brilliant in colour than its close relative, which often looks more white than blue. The range is more restricted than that of the Common Cerulean, being limited to Sri Lanka and South India, then from Nepal to Malaysia. It is interesting that Sri Lanka should have additional species of this genus that do not occur in India.

Nacaduba and related genera

The members of the genus *Nacaduba* at first sight appear somewhat confusing and since their distribution according to Wynter-Blyth is not fully correct, a brief summary will be given here:

Two species, the FOUR LINE BLUES, lack the lines at the base of the forewing underside. Of these *N. hermus* is very much darker than *N. pactolus* whose delicate violet is semi-transparent so that the lines of the underside are faintly visible on the upperside.

Four species belong to the Six-Line Blues, all of which are tailed, and only two of which are listed as South Indian by Wynter-Blyth. *N. kurava* is rather large, with somewhat pointed wings, and a delicate violet ground colour which permits the underside lines to be faintly visible. *N. beroe* and *N. berenice* are smaller and both have more rounded wings; the ground colour is a denser violet and in *N. beroe* the male forewing is clearly overlaid with fuzzy androconial scales that are entirely missing in *N. berenice*. The last species, *N. calauria,* is a dark steely blue, reminiscent of that of *N. hermus.*

The three members of the genus *Prosotas* are only half the size of the *Nacaduba* proper. Of these *P. nora* is tailed while *P. dubiosa* differs mainly in being untailed. The rare *P. noreia* can be told from the others by two characters in the male sex: The cilia of the forewing apical margin is white, and the basal band of the forewing underside is confined to the cell.

The two species assigned to the genera *Ionolyce* and *Petrelaea* cannot be confused with other species.

082. **Nacaduba pactolus continentalis** Fruhstorfer

The LARGE FOUR LINE BLUE is decidedly scarce in the Nilgiris though it has been recorded from Wenlock Bridge, Kallar and Nadgani. Gordon Thompson collected a fine male at Kallar on 2.vi.1986 but we never saw additional specimens. It appears to be a species of the denser forest formations at moderate to medium heights, but too few records are on hand. It is found in Sri Lanka and South India, extending to Hainan and Java in the Oriental region.

083. **Nacaduba hermus hermus** Felder & Felder

I follow Tite (1963) in allocating the South Indian population to the nominate subspecies. The names *nabo, sidoma* and *viola* have also been applied. In the Nilgiris, at least, the species tends to be smaller and darker than the previous one. It is quite rare, turning up here and there in dense tropical or subtropical forest. Wynter-Blyth found it just below Coonoor and at Nadgani in both of which localities I have also taken it. Apart from that I have some from the middle level of the Coonoor Ghat. It is somewhat darker on the wing than the more common *N. kurava* but they share roughly the same habits, including a very fast flight for such a relatively weak looking butterfly. The range covers Sri Lanka and South India, then from Assam to Malaysia and the Philippines.

084. **Nacaduba kurava canaraica** Toxopeus

The TRANSPARENT SIX LINE BLUE is relatively large, with somewhat pointed wings and with the underside pattern showing faintly through the blue ground colour. It is not easily confused with any other species. It is more common than the two Four Line Blues but rarely met with in more than one or twos. The habitat is evergreen forest at all levels from the plateau *sholas* to the foot of Nadgani

Ghat. Occasionally specimens are also found in mixed deciduous forest. Inside the forest specimens fly very fast about naked twigs on which they settle from time to time. The flight is very powerful. They settle avidly on bird droppings and are occasionally found on damp patches. The range covers practically the entire Oriental region in a number of subspecies.

085. **Nacaduba calauria evansi** Toxopeus

The DARK CEYLON SIX LINE BLUE is very like a specimen of *N. hermus* with additional basal lines on the forewing underside, and much darker than the following two species which also tend to be of a lighter violet hue. I collected one specimen of this butterfly at water at the upper reaches of the Nadgani Ghat near the TN/Kerala border. I have not previously seen records of this butterfly from South India; normally it is considered a Sri Lankan speciality in the Indian area. The genitalia of my single specimen match those of Malaysian and Sri Lankan specimens and there can be no doubt about the determination. There are a few battered specimens from the Western Ghats in the British Museum (Natural History) which appear to pertain to this species which must be very rare indeed in South India to have escaped positive identification for so long. Apart from South India and Sri Lanka the species occurs in Malaysia and Sundaland but seems to be scarce everywhere.

086. **Nacaduba beroe gythion** Fruhstorfer

The OPAQUE SIX LINE BLUE has rounded wings of a shining light violet and resembles the next species except that the wings are covered with hair-like androconial scales that are readily visible with a small hand lens, at least in fresh specimens. The distribution in the Nilgiris is essentially in evergreen and mixed deciduous forest at low to medium heights. Most of my specimens have been collected at damp patches on roads and along rivers and I cannot say much about the habits except that bird droppings are visited. *N. beroe* extends into the Oriental Region at least as far as the Philippines and Java. It is found also in Sri Lanka.

087. **Nacaduba berenice ormistoni** Toxopeus

The ROUNDED SIX LINE BLUE is very much like the preceding species except that the wings lack the special, prominent androconial scales, but the genitalia are very different. Very worn specimens are accordingly not easy to determine without dissection. I have seen no records of this butterfly from southern India though it is common in Sri Lanka and its absence from our area would have been surprising. In the event I have a small series from mixed deciduous forest on the Kotagiri Ghat and my impression is that it is less of an evergreen forest species than most of the other *Nacaduba*. Despite the lack of written records there are many South Indian specimens in the British Museum (Natural History). However, I did not find the species common. The species is found throughout the Oriental region and beyond.

088. **Ionolyce helicon viola** Moore
(*Nacaduba helicon*)

The unmistakable POINTED LINE BLUE is very rare in the Nilgiris. No other Nilgiri Lycaenid has so pointed forewings, and there are also differences in the underside patterns. Hampson notes it from about 3000 ft. Wynter-Blyth took a single male at water near Kallar (31.vii.1941). I failed to see it even once. The forewing is so pointed that it would be impossible to confuse a specimen even in a large assemblage of mudpuddling Lycaenidae. It is found in Sri Lanka, South India, and then

from Sikkim east to most of the Oriental region and beyond to the Moluccas and Australia.

089. **Prosotas nora nora** Felder & Felder (*Nacaduba nora*)

The COMMON LINE BLUE is sometimes by far the most abundant butterfly in the lower parts of the Nilgiris, vast swarms being found on wet roads in the mornings, especially during the dry season. Often the closely related *P. dubiosa* is almost as common. When not coming to water the butterflies are very inconspicuous sitting around on broad leaves or on the food plants, species of thorny climbing *Acacia*-type plants that wreak havoc with a butterfly net. They visit the flowers of these plants but otherwise do not seem interested in flowers to any great extent. The underside of this tailed species often has a distinctly ochreous hue. The females are rarely seen though I have taken one or two at water. The distribution of this tiny butterfly spans the entire Oriental region, as well as New Guinea and parts of Australia.

090. **Prosotas dubiosa indica** Evans (*Nacaduba dubiosa*)

But for the lack of tails the TAILLESS LINE BLUE is practically identical with *P. nora* and it is almost as common, sharing the same range and habits. For long it was considered simply a tailless variety, but it is certainly a distinct species. It is less tolerant of extreme arid conditions and in places like Masinagudi *P. nora* is sometimes the only representative of the two. The range covers most of the Oriental region to as far east as Fiji.

091. **Prosotas noreia hampsoni** de Nicéville (*Nacaduba noreia*)

The WHITE TIPPED LINE BLUE may be recognised by two standard indicators: the fringe of the apical area of the forewing when seen against a black background is white; and the basal pair of lunules on the forewing underside does not extend beyond the cell. However, the general aspect of the butterfly is also somewhat different from the two common species. My only specimen was sitting in a big mudpuddling assemblage but I had no difficulty in marking it out as something potentially interesting. Hampson thought it 'fairly common', but he seems to have confused some of his Line Blues. Wynter-Blyth did not find it, and my only record is a male from Kotagiri Ghat (19.v). It genuinely seems to be very rare and is so considered also in Sri Lanka and at Coorg. It is found over much of the Oriental region as far east as Java but is generally rare.

092. **Petrolaea dana dana** de Nicéville (*Nacaduba dana*)

The DINGY LINE BLUE does not have all that much in common with *Prosotas* and *Nacaduba* and is readily identified. Though Hampson called it common this is not in line with subsequent experience. Wynter-Blyth caught one at Ketti and three at Kallar. I have just one from the Kotagiri Ghat (iv.86) in mixed deciduous forest. I have taken it under similar circumstances at Dhimbam in the Biligiriranga Mountains (30.viii), both specimens being caught at damp patches. The behaviour does not seem to differ much from the other Line Blues. It is found in Sri Lanka and in South India, then from Kumaon eastwards to New Guinea via Sundaland. Its absence from the book on Thailand's butterflies (Boonsong *et al.* 1977) must surely be an oversight.

LYCAENESTHINI

093. **Anthene emolus emolus** Felder & Felder (*Lycaenesthes emolus*)

The CILIATE BLUE seems very rare in the Nilgiris where both Hampson and Wynter-Blyth failed to obtain it, though the latter

located a specimen in the collections of the Bombay Natural History Society. I have taken half a dozen males in all on three different dates at the foot of the Nadgani Ghat. Its rarity in the Nilgiris is particularly hard to understand since it is quite common in many localities on the Eastern Ghats in Orissa and in the Himalayan foothills from Nepal eastwards. It flies east to Sundaland, but does not reach the Philippines or Sri Lanka as does the other South Indian member of the genus.

094. **Anthene lycaenina lycaenina** Hewitson (*Lycaenesthes lycaenina*)

The POINTED CILIATE BLUE is quite common in most types of lowland forest during the dry season, but becomes decidedly scarce during the rainy months. It rarely occurs in disturbed habitats. Normally it is only collected when visiting damp patches and, occasionally, flowers. The flight of both the *Anthene* is noticeably faster than that of most other Polyommatinae and when seeing a horde of them flying around a puddling spot, there is usually no problem in picking out the *Anthene*. Females are very rarely seen. The genus is strongly centred on Africa, but the two Indian species have an Oriental distribution. *A. lycaenina* is found in Sri Lanka and South India, in Orissa, and then from Nepal east to the Philippines and Sundaland. Tite (1966) provides an excellent overview of the genus.

095. **Talicada nyseus nyseus** Guérin-Ménéville

The RED PIERROT is a most amazing little butterfly, the only member of its genus, with a colour pattern that is totally different from any other butterfly that I know. Perhaps *Luthrodes cleotas* Guérin-Ménéville from New Guinea is a partial exception; though its ground colour is blue rather than black it shares the red hindwing patch and the basic underside pattern. It is placed last among the Polyommatini since I am uncertain of its exact status within the group. The butterfly is locally abundant from the foot of the Ghats to the highest peaks, accepting a rainfall regime from 500 to 6000 mm. I have seen it on the streets of Colaba in Bombay. Its only ecological requirement seems to be the presence of crassulaceous plants such as *Kalanchoe* and *Bryophyllum*. The young larvae tunnel inside these plants, only emerging from the fleshy leaves when more food is needed. The excreta are not evacuated and the larva lives in a frightful mess. Pupation takes place on the leaf of the food plant. The flight is slow and deliberate, the crimson patches of the hindwings being most visible. The suggestion that it is a protected species is difficult to escape. There are two main centres of distribution. The nominate subspecies is in peninsular India south of Bombay and Orissa. Two other subspecies are found in Assam and Burma.

THECLINAE

ARHOPALINI

096. **Arhopala pseudocentaurus pirama** Moore (*Amblypodia centaurus*)

The WESTERN CENTAUR OAKBLUE is the largest South Indian Lycaenid and, though rather rare, among the most common of the genus in the Nilgiris. The somewhat similar *Arhopala amantes* may be recognised by the presence of well-developed tornal lobes on the hindwings which on the underside have green metallic shading. For application of the names *centaurus* and *pseudocentaurus* see Eliot (1978) for analysis of the tangled story. I have met this butterfly on a number of occasions on the lower reaches of the Nadgani Ghat but never in quantity. There is also a record from Kallar where I think I have seen it as well.

The adult butterfly spends most of its time sitting on broad leaves quite high up and is not much on the wing and then usually making the briefest of flights. Beating the vegetation with a long stick is the best way of flushing it out. Oakblues occasionally come to damp patches but not to flowers, but I have not seen this species at water. The larvae are beautifully camouflaged in green and brown, but their presence is inevitably revealed since they are covered by up to thirty large red tailor ants of the genus *Oecophylla.* Larvae which I brought home died in the absence of ants. The species is found in the wettest parts of South India and Sri Lanka, then from Kumaon east to the Philippines and Sundaland, being replaced by *A. pseudocentaurus* in the Papuan subregion.

097. **Arhopala amantes amantes** Moore
(*Amblypodia amantes*)

The LARGE OAKBLUE is fairly uncommon but, though I did not often see it, probably marginally more common than the preceding species. There are records from Kallar, Burliar, Coonoor Ghat, Kotagiri Ghat and the Nadgani area. It may turn up in evergreen forest of both the tropical and the subtropical variety as well as in mixed deciduous. It has a most irritating habit of alighting at a damp spot for just a split second, then racing off to investigate another one. As is the case with other Oakblues, flowers hold no attraction, but apparently sap exudations are sometimes visited. It is found in suitable forests in Sri Lanka and much of India, extending east to Burma and Thailand. I once found it very common in Corbett National Park in U.P.

098. **Arhopala canaraica** Moore
(*Amblypodia canaraica*)

The KANARA OAKBLUE seems to be a very rare butterfly of the lower reaches of the Western Ghats system, and the only Nilgiri records are by Hampson from the northern slopes. It is smaller than the two preceding species and the male has a black border of 1 mm. The very rare Tamil Oakblue (*Arhopala bazaloides*) is also to be expected. Its ground colour is more purple than in the other three and the black border of the male is 2 mm broad. I never came across either in the Nilgiris, but I did collect a few *A. canaraica* near Karkala in South Kanara. The species is only found on the Western Ghats.

099. **Arhopala abseus indica** Riley
(*Amblypodia abseus*)

The ABERRANT OAKBLUE is smaller than the others with a characteristic, variegated underside. It must be considered rare in the Nilgiris since the only record is one seen at Kallar by Wynter-Blyth on 28.iii.1943. Apart from a Coorg specimen this was the only record from South India, but it has been seen by A. J. Sharman in the Palnis (Rodericks & Ugarte 1960). It is also rare in Sri Lanka, but much more common from Nepal east to the Philippines and Borneo.

100. **Thaduka multicaudata kanara** Evans

The MANY-TAILED OAKBLUE, not closely related to the real Oakblues, is a lovely butterfly with its metallic blue colour and the four fluttering tails. It may not really belong in the Amblypodiini. It has the reputation of being everywhere rare to very rare, probably at least partly because it does not fly much spontaneously. I have found it most frequently not in the forest proper but along rivers at the edge of forest. It is not uncommon along the Coonoor and Kotagiri rivers where they join at Kallar and I have seen up to a dozen in a day. Rather surprisingly Wynter-Blyth failed to find it in the Nilgiris. Normally it is necessary to beat it out of low bushes since it never visits flowers and not normally damp patches

either. This is the toughest butterfly I have ever come across. It is practically indestructible. Pinched several times in the traditional way, in a manner that would kill even a Danaid, chances are that it will happily fly off when the envelope is opened several hours later. This type of toughness is normally the prerogative of protected species, but I have also encountered it in the Hesperiid, *Bibasis sena.* The distribution is strongly disjunct, covering the Western Ghats system, Burma and Thailand. The genus is monobasic.

101. **Surendra quercetorum biplagiata** Butler

The COMMON ACACIA BLUE is usually a species of the lowland wet zone, which is local, but occasionally common, sometimes very common at Kallar. The male is violet, the female brown. The disposition of the tails differs between the two sexes. The adult butterflies spend much of their time sitting on twigs and fresh shoots, often those infested with ants, and usually head down. Often three to five are found in little clusters, sometimes physically sitting on top of each other. At Kallar they often sat on the flowers of Lantana but paid no attention to nectar. I have seen females at the nectaries of leguminose plants, again in the company of ants, but I was never able to satisfy myself that they really took nourishment. There is not much spontaneous flight activity and any flights are of very short duration. Adult butterflies occasionally bask with the wings three-fourths open. The range covers Sri Lanka and South India, then from about Simla to Indo-China. In Sundaland proper it is replaced by *S. vivarna* whose female is purple.

102. **Zinaspa todara todara** Moore (*Surendra todara*)

The SILVER STREAKED ACACIA BLUE was recorded as common by Hampson, but according to Yates (1935) this is because he confused it with *Surendra quercetorum,* while recording females of the present species under the name of *Rapala distorta.* Wynter-Blyth failed to find it and I have found it very scarce. I have a specimen from Nadgani Ghat on the TN/Kerala border (12.v) and I have seen it in the moist-deciduous forest of the Wynaad Wildlife Sanctuary. I also have a female from moist-deciduous forest in the Biligiriranga Mountains below the Honametti Estate. The species really does appear to be scarce in South India. The genus is monobasic and the species recurs from Sikkim to Thailand and Malaysia. It is curious that it should not occur in Sri Lanka.

AMBLYPODIINI

103. **Iraota timoleon arsaces** Fruhstorfer

The SILVERSTREAK BLUE is one of the most handsome of all the South Indian Lycaenidae and the variegated underside is unmistakable. It is unfortunately rare in the Nilgiris. Hampson mentions it, giving no details, and Wynter-Blyth failed to collect it. Between 16 and 29.vi Gordon Thompson and I took a few specimens on fig trees along the Coonoor river at Kallar and saw quite substantial numbers of very worn specimens. They were probably the progeny of a single female and despite careful monitoring of these trees over the next five months none was seen again. The species appears to be found in hilly country with reasonable rainfall, but not necessarily in evergreen forest. Though the larvae will feed on most species of *Ficus* the butterfly is very local. Perhaps some special combination of figs and attendant ants are needed. It is rare in Sri Lanka, fitfully distributed and not normally common in peninsular India, then from Simla east to southern China, Hong Kong and Malaysia. Other members of the genus popu-

late the remainder of the Oriental region.

104. **Amblypodia anita dina** Horsfield
(*Horsfieldia anita*)

The LEAF BLUE is decidedly rare in the Nilgiris having been recorded only by Hampson. Possibly the climate is on the wet side since the species is not uncommon in the drier jungles of eastern Madhya Pradesh and Chota Nagpur. It will only be found in reasonably undisturbed jungle and is an insect that does not take to the wing very often. It may be met with in some numbers on damp patches and sometimes on carrion or bird droppings. The shape and underside pattern is a miniature replica of that of the *Kallima* butterflies. The range is from Sri Lanka, through suitable places in peninsular India to Malaysia and Java. Other members of this small and compact genus are to be found in the remainder of the Oriental region and in the Papuan subregion.

APHNAEINI

105. **Spindasis vulcanus vulcanus** Fabricius

The COMMON SILVERLINE is a species of open lowland country which I have taken at Kallar, Mettupalayam, Kotagiri Ghat and Masinagudi. The orange markings of the forewing upperside are generally well developed in both sexes in contrast to *S. schistacea.* Wynter-Blyth found it very common on the lower plateau near Ketti in November and December. I think he must have chanced upon an exceptional situation. All the *Spindasis* are somewhat unpredictable in their occurrence and frequency and though usually not numerous there may be temporary abundance (thus at Gir Forest in Gujarat in October 1986 I saw more *S. elima, S. vulcanus* and *S. ictis* during one day than throughout four years of collecting in all of India). The flight is extremely rapid and how courting couples manage to maintain visual contact during their frenzied courtship flights is a source of wonder. However, the members of genus are fond of flowers, not least *Tridax*, and are then easily netted. The species is endemic to Sri Lanka and the Indian subcontinent.

106. **Spindasis schistacea** Moore

The PLUMBEOUS SILVERLINE is very similar to the Common Silverline but normally the males have obscured orange markings on the forewing upperside and a small patch of shot blue scales in the tornal area of the hindwings. My only female is a silvery grey and very different from any other *Spindasis* I have seen. *S. schistacea* seems to be found in more mesic country than *S. vulcanus* and I have taken it at Nadgani, Kallar and the forests below Glenburn, as well as at Sholayar in the Annamalais. The habits are those of the genus. The species is endemic to peninsular India and Sri Lanka.

107. **Spindasis ictis ictis** Hewitson

The SHOT SILVERLINE is scarce in the Nilgiris area and was not mentioned by Hampson or Wynter-Blyth. It does figure in the revised Nilgiri list of Yates (1935) though with no supporting data. It is one of the most seasonally variable butterflies that I know of, extreme dry season forms lacking most trace of the normal bands on the underside. I have taken it at Masinagudi on two occasions: a dry season form on 18.v and a wet season form on 9.vi in the very same spot. Though many Silverlines live in dry habitats they never frequent damp patches. The species is endemic to the Indian peninsula and Sri Lanka.

108. **Spindasis elima elima** Moore

Hampson recorded the SCARCE SHOT SILVERLINE as 'common, 2000-4000 ft' with no addi-

tional detail. This is not in accord with subsequent data. Wynter-Blyth records a single specimen from Kallar, and I have failed to find it. I did see hundreds in so unlikely a place as the Gir Lion Sanctuary in Gujarat. Moore's names *trifurcata* and *lunulifera* have been used instead of *elima* by some authors, but given the virtual absence of Nilgiri material I have not looked into the matter. The species is endemic to Sri Lanka and peninsular India and is probably mostly associated with slightly less dry habitats than is *S. ictis.*

109. **Spindasis abnormis** Moore

The ABNORMAL SILVERLINE is easily recognised by the fact that most of the usual bands of the underside are obsolete, leaving only the central discal bands with any prominence. It was described after a few Coonoor specimens collected in 1880. A very few were then taken in the Coorg area. Florence found additional specimens near Coonoor early this century since then very little additional material has come to hand. One must assume that this South Indian endemic is strictly localised, and in all probability linked to some fairly obscure species of ant, since the genus has one of the closest symbiotic relationships with ants of all the Lycaenidae.

110. **Spindasis lohita lazularia** Moore

The LONG-BANDED SILVERLINE is perhaps the prettiest of the South Indian members of the genus. The upperside is a deep shot blue with a prominent orange patch at the tornus, though the female is a dull black. It is more of a forest insect than the others and may be found in lowland mixed deciduous forest and in the evergreen formations. It is not very common and I have less than a dozen picked up as single specimens in many localities, usually while feeding from the flowers of *Acacia horrida* and other thorny leguminose plants. Wynter-Blyth doubted its presence in the southern Nilgiris but I have caught it on the Kotagiri Ghat as well as at Kallar. The range covers Sri Lanka and South India, a few chosen spots in central and eastern India, then from Kumaon east to Taiwan, Hong Kong and Sundaland.

CATAPAECILMATINI

111. **Catapaecilma major callone** Fruhstorfer

The name *myositina* Fruhstorfer is normally associated with the South Indian populations of the COMMON TINSEL, but Cantlie (1962) insists that this should be limited to the Ceylon population which is morphologically different from the South Indian one. Though Hampson called it 'common' the Common Tinsel appears to be relatively scarce in the Nilgiris. Wynter-Blyth failed to find it during four and half years of intensive collecting and I have only taken two in widely separated spots in the Nadgani area. On 1.x.1986, S. Imber found a thriving colony at Kunjapannai in an area I had exploited frequently without seeing the species. Elsewhere it has been taken in a wide variety of habitats, even as high at 1600 m at the St. Catherine's Falls near Kotagiri where I took it in 1956. I took a good series in very dry country in the foothills of the Palnis in July 1984. Wynter-Blyth (1957) adduces evidence that in both Sri Lanka and southern India it has entered a cyclical decline since the 1880ies. I have personally not found any species of *Catapaecilma* common anywhere else in the Oriental region. The species is found in Sri Lanka, South India, along the Eastern Ghats, then from Mussoorie east to Taiwan and south to Malaysia. Other species inhabit the rest of the Oriental region.

LOXURINI

112. **Loxura atymnus atymnus** Cramer

The unmistakable YAMFLY is not rare and sometimes common in the wetter lowland

forest formations, especially where bamboo is present, and it may sometimes be found in the vicinity of villages. Normally the butterfly flutters weakly in the shade but it has a capacity for rapid flight if disturbed or faced with open sunshine. I have not seen them on flowers, but they seem to be attracted to homopteran insects, especially those feeding on their larval food plants, *Smilax* and *Dioscorea,* but I have not positively seen them imbibing the sugary secretions. The inevitable traffic of ants in such places does not disturb the butterflies. The species is found in Sri Lanka, suitable localities on the Indian Peninsula, then east to Sundaland and the Philippines.

CHERITRINI

113. **Cheritra freja freja** Fabricius

The COMMON IMPERIAL may be found in small numbers on the Nadgani Ghat, and in the Nilgiris it seems to be limited to the wettest tracts of lowland evergreen forest. The long tails make confusion with any other South Indian butterfly but the much darker *Bindahara phocides* impossible. The South Indian population is normally known under the subspecific name of *jaffra,* but Harish Gaonkar has examined the Fabrician type of *freja* in Copenhagen and it is clearly of South Indian origin, like much else of Fabricius' type material. Hampson found it on the western slopes, Wynter-Blyth did not obtain it, while I have seen it on most visits to the Nadgani Ghat. I have never seen it on flowers or at water. Males sometimes perch on a prominent leaf, usually out of reach, sometimes with the wings three-fourths open. From such perches they may launch brief flights. Good specimens are difficult to procure since the tails often break off in the net. In dull weather the butterflies settle under leaves. It is amazing that they can manage this act without the tails getting in the way. The range covers Sri Lanka and South India, then from Kumaon to Indo-China and Sundaland.

HORAGINI

114. **Rathinda amor** Fabricius

The MONKEY PUZZLE is a very distinctive little butterfly in a monobasic genus that is found only in Sri Lanka, South India and Assam. It is a retiring species that has to be looked for actively in the mixed deciduous forest that constitutes the main habitat. It is usually found sitting on the top of broad leaves, sometimes with the wings three-fourths open basking in the sunshine. When disturbed it will only fly a short distance and the flight is very weak by the normal standards of the Theclinae. The larva is covered in long fleshy tubercles, supposed to give a monkey food for thought and responsible for the English name (!?). The pupa is attached only by the cremaster, lacking the girdle round the thorax. These two traits unite *Rathinda* and *Horaga.*

115. **Horaga onyx cingalensis** Moore

The COMMON ONYX is very rare in the Nilgiris. Hampson recorded it as 'rare', Wynter-Blyth and I failed to find it, though I did see a specimen in the Biligiriranga Mountains. Generally it is found in dense shrub or forest undergrowth, not necessarily that of the wettest types. Thus, it is reputedly not rare in the vicinity of Bangalore. The habits are probably somewhat like those of *Rathinda amor.* The range covers Sri Lanka and South India, then from Kangra east to Taiwan, Hong Kong and Sundaland.

116. **Horaga viola** Moore

The VIOLET ONYX is a rare little butterfly whose exact taxonomic status has been the

subject of considerable discussion. It is very rare in the Nilgiris but it is mentioned in the list by Yates (1935). I have no personal experience of the insect, but it probably frequents slightly more mesic habitats than the preceding species. It is found in Sri Lanka and South India, as well as Burma. It is not mentioned from Thailand by Boonsong *et al.* (1977) and taxonomic and nomenclatural issues make it difficult to say how far it penetrates into the Oriental region (possibly to the Philippines and Sundaland).

ZEZIINI

117. **Zezius chrysomallus** Hübner

The REDSPOT is a very distinctive butterfly in a monobasic genus that is endemic to Sri Lanka and the Indian subcontinent. While local, it is not rare, and may be found in lowland country under a large variety of ecological conditions. It is rare in the Nilgiris, however, Hampson caught a single female and Wynter-Blyth found a single male forewing at Kallar. Over the six months that I spent in the Nilgiris I collected a dozen or so at Kallar with the help of Gordon Thompson. Of these three were males. We sometimes found both sexes sitting on a bush infested with *Oecophylla* ants which are known to tend the larva. Three of the Kallar females were taken at water as was a single specimen at Ronningtown, rather unusual in the Theclinae. A female from the foot of Nadgani Ghat is so different from the others that one would spontaneously consider it a distinct species. The upperside is a more or less uniform dark brown with a coppery sheen instead of powdery blue with broad brown borders. The underside is very dark with the space between the heavily marked lunules filled in with red, contrasting strongly with the lightly marked underside of the usual female. Only the unique disposition of the spots of the underside and the special arrangement of the tails make it certain that it is a Redspot. It is presumably a product of the extreme humid conditions of the Nadgani locality.

IOLAINI

118. **Ancema blanka argentea** Aurivillius (*Pratapa blanka*)

The SILVER ROYAL is the first of a series of seven very beautiful strong blues, most of which have eluded me, all being genuinely rare to very rare in the Nilgiris. The underside of the male in this species has a special silver sheen that will distinguish it from all other South Indian species. Yates (1935) records a Nilgiri specimen taken by Stokes-Roberts and Wynter-Blyth collected a single female at Kallar on 22.viii.1941. I did not come across it. It is found in South India, and then from Sikkim to Sundaland.

119. **Creon cleobis cleobis** Godart (*Pratapa cleobis*)

The BROADTAIL ROYAL is rare at medium heights in the Nilgiris according to Hampson. Wynter-Blyth took a single specimen below Coonoor on 2.x.1942 and there is a record of one from the Gudalur Dak Bungalow (Yates 1935). I caught a fresh male on the flowers of *Polygonum* in my Kotagiri garden on 6.x.1986, a most surprising record as the garden was normally a butterfly desert. The underside is a creamy brown that differs from the other related species. The genus is monobasic and the single species is found in South India and then from Simla east to S. China, Hong Kong and Malaysia.

120. **Pratapa deva deva** Moore

The WHITE ROYAL has been recorded from Kallar and the Mettupalayam Ghat, but I have not come across it. It is found on Sri

Lanka, in South India, through suitable localities in peninsular India to Ambala and east to Sundaland.

121. **Tajuria maculata** Hewitson

The SPOTTED ROYAL with its white underside adorned with large, disjunct black spots is quite unmistakable. Yates (1935) includes it in his list on the basis of a Stokes-Roberts specimen in the de Nicéville collection. All the new records to the Nilgiris based on his material have since been validated by others and the species is so distinctive that it is difficult to see how a labelling error would have survived. Otherwise the range covers the area from Sikkim to Sundaland and there appears to be no geographical differentiation. If it is a genuinely South Indian species a long series from more than one locality is a great desideratum. It could well be an undescribed subspecies.

122. **Tajuria cippus cippus** Fabricius

The PEACOCK ROYAL also seems to be rare in the Nilgiris though generally speaking it is more common than most of the members of this group of genera. It is also much less demanding in habitat choice. Wynter-Blyth failed to find it. I am almost certain that I saw it near Masinagudi, but it might just have been *T. jehana.* It ranges from Sri Lanka through much of India to South China and Sundaland.

123. **Tajuria jehana** Moore

The PLAINS ROYAL does not figure on Wynter-Blyth's original Nilgiri list but is mentioned from Kallar and below Coonoor in a later supplement. It also figures in Yates (1935) as collected by Winkworth. I have a specimen from Kallar (28.v). Given the Kallar records I suspect that this is the species which Gordon Thompson saw on a *Loranthus* infested chikoo tree at Rahman Gardens in Mettupalayam. All members of the group feed on loranthaceous plants. The species is closely allied to *T. cippus* but is endemic to Sri Lanka and peninsular India.

124. **Tajuria melastigma** de Nicéville

The BRANDED ROYAL is a rare species that was recorded from the Nilgiris by Hampson and of which Wynter-Blyth saw a specimen from a local collection probably from the Mettupalayam Ghat. The underside is brownish with a rosy tinge. The species is endemic to India and Burma having been recorded from the Nilgiris, Kanara and the Himalaya from Kumaon to Burma. It is generally considered to be rare.

125. **Rachana jalindra macarita** Fruhstorfer
(*Charana jalindra*)

The BANDED ROYAL is a handsome butterfly that is very rare in South India. Wynter-Blyth collected a male at Burliar in April and a female at Ketti in June. Since the species is normally associated with lowland evergreen forest the Ketti record is curious. On the underside the outer third of all four wings is a rich chocolate, making it very different from all other South Indian species of the group. All members of the Iolaini (*Ancema, Creon, Pratapa, Tajuria, Rachana*) feed on parasitic mistletoes of the genera *Loranthus, Dendrophthoe* and *Scurrula.* They rarely stray far from the trees on which the plants grow, nor are they much given to flying spontaneously. They only rarely visit flowers and even more rarely damp patches and hence they probably seem scarcer than they actually are. *A. jalindra* is found in South India, then from Nepal east to Sundaland, generally being rare throughout its range.

HYPOLYCAENINI

126. **Hypolycaena nilgirica** Moore

The first specimen of the NILGIRI TIT was caught in the Nilgiris just about one hundred years ago by one A. Lindsay. It was later collected also in the Palnis and a few specimens turned up in Sri Lanka. Hampson did not record it, Wynter-Blyth took a total of fifteen at Kallar where I have taken three on different dates. Kallar would thus appear to be a headquarters of sorts for a rare and local butterfly. I have only seen it at water and know nothing of its behaviour except that the flight is weak and fluttering, so much so that confusion with *Ypthima ceylonica* is a possibility. Nothing is known about the early stages.

127. **Chliaria othona othona** Hewitson

The ORCHID TIT is rare in South India and is recorded here from the Nilgiris for the first time on the basis of a single fresh male that I caught at water in the forests below Glenburn on 12.vi.1986. The underside and genitalia of this and the preceding species are so similar that they should possibly be treated as congeneric. It is fitting that the larval food plants of such a pretty and delicate little butterfly should be species of orchids. It seems likely that the species is limited to lowland and subtropical evergreen forest in the Nilgiris. It is found in South India, then from about Dehra Dun east to at least Malaysia, but further east taxonomic difficulties makes it difficult to say which exact species are represented.

128. **Zeltus amasa amasa** Hewitson
(*Zeltus etolus*)

The FLUFFY TIT appears to be very rare in the Nilgiris. Hampson took three females in the Nadgani area in 1888 and I have a single female from near the foot of the Ghat. Wynter-Blyth failed to procure it. It appears to be limited to lowland evergreen forest in our area. It is much more common elsewhere in its range which stretches from Nepal east to Hainan, the Philippines and Sundaland. The genus is monobasic.

DEUDORIGINI

129. **Deudorix epijarbas epijarbas** Fabricius

The CORNELIAN is a widely distributed butterfly that is remarkably scarce in the Nilgiris. Wynter-Blyth obtained one at Runnymede and two at Kallar, from where I also have two (2.vi and 13.viii) both collected by Gordon Thompson. The species is often quite common in a wide variety of habitats to as high as 2500 m in the Himalaya so its scarcity in the Nilgiris is doubly puzzling. It is not rare in lowland Sri Lanka, found in suitable localities throughout peninsular India, then practically throughout the Oriental region, extending via New Guinea and Australia as far into the Pacific as Samoa.

130. **Deudorix isocrates** Fabricius
(*Virachola isocrates*)

The COMMON GUAVA BLUE is another species that is rare in the Nilgiris despite being quite common on the open plains of Sri Lanka and peninsular India. Hampson gives an upper limit of about 1200 m but no further details. Wynter-Blyth caught one at Kallar (28.iii) and saw one at Nadgani in December. I never came across it despite checking hundreds of guava and pomegranate trees, the favourite, but not exclusive, larval food plants. In addition to India and Sri Lanka the range covers Burma and Thailand.

131. **Deudorix perse ghela** Fruhstorfer
(*Virachola perse*)

The LARGE GUAVA BLUE is another rarity in

the Nilgiris. Hampson mentions it as '2000-4000 ft' with no details and I know of no further records. It is a denizen of more forested country than is *Deudorix isocrates* but they are otherwise very similar in both facies and habits. The range covers Sri Lanka and South India, then from Kangra east to Burma, Thailand and the Philippines. There is a population also in the Eastern Ghats.

132. **Bindahara phocides moorei** Fruhstorfer

The PLANE in the Nilgiris is found mainly on the western slopes where Hampson collected 15 specimens and where I have seen small numbers on several occasions in dense forest on the Nadgani Ghat and near Rousden Mullai estate at Devala. On 23.v a specimen unexpectedly turned up at Kallar. Wynter-Blyth caught one at flowers near Ketti (1900 m), a most unexpected record since the species is definitely essentially one of the lowland evergreen forests. The flight is rapid, often inside dense vegetation, and I have found it very difficult to capture in good condition. Apart from Sri Lanka and South India, the species occurs from Sikkim east to practically the entire Oriental region, thence to Australia and the Solomon Islands.

133. **Rapala iarbus iarbus** Fabricius
(*A. iarbas* & *R. melampus*)

Some authors would distinguish the South Indian populations of the INDIAN RED FLASH as ssp. *sorya* Kollar, but the species is so widely distributed, variable and probably migratory that I do not feel there is much point in doing so. It is another widely distributed plains butterfly, often common, that is curiously scarce in the Nilgiris, the only record being Hampson's note '2000-7000 ft'. It is probably best looked for in places like Masinagudi and in mixed deciduous forest, but I found no trace of it. The species is distributed practically throughout the Oriental region and beyond.

134. **Rapala lankana** Moore

Despite the scientific name the English name of this very scarce butterfly is the MALABAR FLASH. It is endemic to Sri Lanka and the Western Ghats and there are a few Nilgiri records. Hampson records it as '1000-3000 ft, not common', presumably on the western slopes. A local collector, Gopalkrishnan, showed me a photograph of one in a Japanese collection and thought it was from the Nadgani area. Very little is known about this butterfly.

135. **Rapala manea schistacea** Moore
(*Rapala schistacea*)

The SLATE FLASH is relatively scarce in the Nilgiris, though I would not accept Wynter-Blyth's view that it is very rare outside the western slopes. I have regularly picked up single specimens on the Kotagiri Ghat, near Glenburn, at Kallar and at various points of the Coonoor Ghat in addition to Nadgani. I have just over a dozen, all females, and mostly caught on the flowers of *Acacia horrida,* a thorny creeper that can wreak havoc to a butterfly net. It is found in Sri Lanka, wooded parts of the Indian subcontinent with adequate rainfall, east to Thailand and Burma and perhaps deeper into the Oriental region where the taxonomy of the group becomes very difficult.

136. **Rapala varuna lazulina** Moore

The INDIGO FLASH is much rarer than the preceding species, notwithstanding Hampson's comment that it was common. Wynter-Blyth did not find it and I have but three females, all collected at the level of about 1100 m on the Coonoor and Kotagiri Ghats. One settled on the shirt of a passenger awaiting the depar-

ture of the toy train from Benhope Station. His surprise at my catching a butterfly off his shirt with my fingers was at least as great at my seeing the species in this manner. It is found in Sri Lanka, South India and from Kangra east at least to Malaysia and probably beyond.

CURETINAE

137. **Curetis thetis thetis** Drury

The INDIAN SUNBEAM is the most common of the three *Curetis* in South India, but it is still not an insect which is met with anywhere on any day. The female is the only one with white instead of orange markings. The narrow black border of the male is not continued along the termen of the forewing and the ground colour is more intense than in the two other species. It is not too rare at Kallar, where females are often seen on *Pongamia glabra*, a favourite larval food plant. I have seen it on the Kotagiri Ghat and I have taken specimens also at Nadgani and Ronningtown. The males are mostly taken at damp patches, usually by themselves and not as members of the larger mudpuddling assemblies. They are inordinately fond of bird droppings. I have seen as many as three on one small dropping, so engrossed in their task that when I lowered the net over them they remained sitting. Occasionally a male may be seen basking in the sun with the wings three-fourths open, but otherwise they manage to stay out of sight. The species is endemic to the Indian subcontinent, Sri Lanka and Burma. Records from further east pertain to populations now considered to be distinct species.

138. **Curetis dentata dentata** Moore

The DENTATE SUNBEAM and the following species, *C. siva* are very similar and may be distinguished as follows: In the former the discal band on the hindwing underside, faint as it may be, is strongly disjunct, the streaks in spaces 6 and 7 being inwardly displaced almost to the end cell; in *C. siva* the band is almost continuous all through spaces 2 to 7, much as in the otherwise very different *C. thetis.* I have a few specimens from the Nadgani Ghat but Wynter-Blyth caught the species (or possibly *C. siva*) at Kallar. All but one of my four or five specimens were taken on bird droppings. The distribution of the species covers South India, then from about the level of Kulu east to Indo-China and Hong Kong.

139. **Curetis siva** Evans

The SHIVA SUNBEAM was described by Evans (1954) and is endemic to South India with firm records from Travancore (Kerala), Mysore, Coorg, N. Kanara and the Nilgiris. The distinguishing characters are given under the preceding species. I have not come across it and the only record I have is the original description.

RIODININAE

140. **Abisara echerius prunosa** Moore

The PLUM JUDY is the only South Indian representative of this distinctive subfamily, given family rank by many authors. Older Indian literature often lumped the Riodininae and the Libytheinae as the Erycinidae, though the two are phylogenetically as far apart as almost possible. The species is mainly found in lowland and subtropical evergreen forest though in my childhood there was a permanent colony in an old fruit plantation at Kotagiri (1900 m). It is not rare, but is best met with early in the morning when the males perch on leaves along forest paths. Later in the day they retire to some more secluded roost. They are rarely seen away from dense forest. Neither

sex seems interested in flowers or damp patches. The species is found in South India and Sri Lanka, suitable parts of peninsular India, extending in a northerly pattern to Indo-China and the Philippines. Other similar species replace it in Sundaland. The genus is also represented in Africa.

Nymphalidae

Danainae

Danaid butterflies are well known for their need to frequent sources of pyrrolizidine alkaloids which are essential for the males to prime the pheromones that are necessary for successful courtship. Ackery & Vane-Wright (1984) give a good review of this phenomenon. Before dealing with the individual Danaid species it is worthwhile summarising the information I obtained on this issue in the Nilgiris in the form of an introduction since more than one species is usually involved at each pyrrolizidine alkaloid source.

From the very beginning of my stay in the Nilgiris many coffee plantation managers spontaneously informed me of large assemblages of *Tirumala septentrionis* and *Euploea* species on a large, yellow *Crotalaria*, a known alkaloid source that is sometimes interplanted with coffee. Their enthusiastic descriptions of this phenomenon made it clear that hundreds or even thousands would be present at the same time. I have personally only seen the occasional specimen on this plant.

At Ronningtown I found a large *Heliotropium* that had been overturned in such a way that a cave some 30 cm deep had been excavated around the root system. At any given time up to fifty Danaids were settled on the plant or more especially the upturned and exposed roots (*Danaus chrysippus, D. genutia, Tirumala septentrionis, E. core, E. sylvester*). Many crawled into the cave beneath the plant, jostling with each other to get at the best roots. Heliotrope is again well known as a pyrrolizidine alkaloid source.

At Kallar I found thousands of the same five species on *Ageratum conyzoides* that had been sprayed with weedicide inside the extensive Arecanut plantations, usually in little clusters of three to five individuals on the chosen plants. According to Gordon Thompson the plants were most attractive about three days after weedicide application, so that the butterflies moved about the plantations according to dates of spraying.

By the Coonoor river at Kallar I once found fourteen *Tirumala septentrionis* on the tiniest possible cut stump of an unidentified plant, crammed so closely together as to be hardly believable. Most ingestion of pyrrolizidine alkaloids takes place as a social activity, almost exclusively male. I suspect that the social aspect is simply because the easiest way for a Danaid to localise an alkaloid source is by the proxy of looking for other males.

141. **Danaus chrysippus chrysippus** Linné
(*Danais chrysippus*)

The plain or common tiger is one of India's most widespread and well-known plains butterflies, being very common also in disturbed areas, villages and agricultural land. No resident of India can have escaped seeing it. It avoids deep evergreen forest and becomes progressively rare as one ascends the mountains, and I do not think it breeds regularly on the plateau of the Nilgiris. The species is migratory, but it constituted only a small fraction of the migrations that I have seen in the area. The butterfly is essentially monomorphic in South India the two regular forms being of extreme rarity, though the form with white hindwings has become predominant in Malaysia and North Sumatra this

century. The range is vast, covering all the old world tropics with some penetration into the Palaearctic in China, the Middle East and the Mediterranean.

142. **Danaus genutia genutia** Cramer
(*Danais plexippus*)

The STRIPED TIGER is widespread throughout the Nilgiris in most types of country though it is rarely very common. Only at Ronningtown have I seen it in very large numbers. It is, however, more at home in the wetter forests and on the plateau than is *Danaus chrysippus.* It participates in the migrations with other Danaids and may also share communal roosts for the night. It comes to water occasionally, certainly more frequently than *D. chrysippus.* It is found practically throughout the Oriental region, and in Australia, but not on New Guinea.

143. **Tirumala limniace exoticus** Gmélin
(*Danais limniace*)

The BLUE TIGER is generally a common butterfly in peninsular India but it is scarce in the Nilgiris, being outnumbered by *T. septentrionis* by a factor of at least 100 to 1. This was also the experience of Wynter-Blyth in the 1940ies. In the drier tracts, such as at Masinagudi, both species are scarce, but equal in number. The species is migratory and may occasionally be met with on the high plateau, but I doubt that it ever breeds there except in exceptional cases. The species is found in most of the Oriental region, but is absent from Sumatra and Borneo, where *T. septentrionis* is present. The African populations are now considered to be specifically distinct from *T. limniace.*

144. **Tirumala septentrionis dravidarum** Fruhstorfer
(*Danais melissa* (*hamata*))

The DARK BLUE TIGER is found in the forests of the lowland and the subtropical zones, but is not normally resident on the plateau, though migrants, stragglers and the occasional temporary population may occur. It is sometimes very common indeed at lower levels with large numbers coming to water, especially where salts are present. I have seen cows licking water sources on vertical mud faces also utilised by this species. It is one of the major components of migratory activity in southern India whenever mixed migrations occur. The range covers Sri Lanka and South India, then from Himachal Pradesh east to Malaysia, Sumatra and Borneo. *T. limniace* is absent from these two islands, but it is present on Java and Sulawesi, from where *T. septentrionis* is absent.

145. **Parantica aglea aglea** Cramer
(*Danais aglea*)

The GLASSY BLUE TIGER is often reported to be common or very common but that is not normally the case in my experience. Certainly it is best classed as not rare in the Nilgiris, being found practically anywhere where there is decent forest, but in small numbers only. It may be found also in more open country on occasion. Wynter-Blyth apparently did not find it much above 5000 ft, but it is certainly resident at 2000 m in the Longwood Shola near Kotagiri. It is a much weaker butterfly than the two *Tirumala* and usually only emerges from forest when seeking the flowers of Lantana. I have not seen it at damp patches but would not rule out that it occasionally frequents them. I have never seen it migrating in the Nilgiris, but I did see large numbers as part of mixed migrations in the Konkan in October 1986. It is found in Sri Lanka and South India, then from the level of Jammu to Hong Kong and Malaysia, being replaced by very similar species further east.

146. **Parantica nilgiriensis** Moore
(*Danais nilgiriensis*)

The NILGIRI TIGER is an unmistakable species that is endemic to the higher mountains of southern India and most closely related to *P fumata* Butler, a Sri Lankan endemic. It is basically a butterfly of the evergreen *sholas* of the plateau, but it may be found in more open country as well, though the extent to which it breeds outside of the forest is doubtful. It descends to the subtropical evergreen forests and I have exceptionally seen it as low as 1000 m. The flight is rapid, low and erratic for a Danaid, giving the impression that it may not be a protected species. The flight pattern reminds one of the day flying moth *Aglia tau* of northern Europe as it makes its way through the spring beech forests. It is often seen in numbers on flowering trees or on the occasional Lantana in clearings in *sholas*. From time to time it is also met with sipping moisture from water seepages in vertical banks in the forest or along clear brooks, something that may also be observed in other montane butterflies.

147. **Idea malabarica** Moore
(*Hestia lynceus*)

The MALABAR TREE NYMPH, like the other members of the genus, is a true delight to watch as it makes its way slowly through the lower parts of the forest canopy in a ghostly fashion, sometimes exposed to sunlight as it crosses a glade or a forest road. Often little companies of up to a dozen specimens will be performing a muted aerial ballet as they circle about some communal cross-roads. The butterfly is a South Indian endemic, limited to wet evergreen forest of the Western Ghats system, replaced by the ecologically somewhat more tolerant *I. iasonia* Westwood in Sri Lanka. Other species occur from the Sundarbans eastwards, though rarely are more than two species found in any one locality. I have never seen them at water, but despite the statement by Ackery & Vane-Wright (1984) that they rarely or never visit flowers, I have seen them on Lantana and flowering jungle trees on many occasions. They are, though, less avid nectar seekers than most other Danaids. The flight is effortless at all times and their ability to hover in the same spot for minutes on end is remarkable, but when needed they can make very rapid progress indeed. The species is quite common in the right type of habitat.

148. **Euploea core core** Cramer

The COMMON CROW is abundant at lower and middle heights in all types of terrain. It is also strongly migratory. Though seen regularly on the plateau it is probably not truly resident. During the dry season large roosts of this and/or the next species are frequently found in cool forests, sometimes in the company of other common Danaids. Damp patches are attractive at certain times, at others not. Various types of diapause mechanisms seem to be operating in the species, but I have not been able to determine their exact nature and timing. For a winter roost of Danaids in Corbett National Park see Larsen (1987d). Many early authors have remarked on the habit of this and other *Euploea* of patrolling a limited territory with the abdominal hair pencils fully extended even though no females or rival males are in sight. I have witnessed more than fifty such displays, often lasting half an hour or more. The hair pencils are extended, the abdomen curled downwards, the wing beat slow and more precise than normal. The area patrolled is very small, usually not more than five to ten metres in diameter and sometimes less. In an open forest near Glenburn I could see more than ten males at any given time. During several hours of combined observation I never saw male-male interaction, nor did I see any females approach or being courted.

I never saw *Euploea sylvester* engage in this type of behaviour. On three occasions I have seen courtship displays, though neither the inception, nor the final copula. Here the male hovers above a sitting female, standing almost still in the air some 10 to 15 cm from the female. If the female moves, the male follows. At this stage of courtship I never saw the hair pencils extended. The species is found from Sri Lanka to most of the Oriental region and Australia to the Pacific, but according to Ackery & Vane-Wright (1984) it is lacking from Borneo, Sulawesi and the Philippines.

149. **Euploea sylvester coreta** Godart
(*Euploea coreta* & *E. harrisi*)

The DOUBLE BRANDED CROW differs from the Common Crow in having two long prominent brands along the termen of the forewing upperside instead of one small brand, but in flight there is no difference. The abdominal hair pencils are a sullied yellow rather than the rich egg-yolk yellow of the common Crow. This is also a common species, but it is less at home in the drier habitat than is *E. core.* In the large migration of May 1986 (Larsen 1987b) both species were present in roughly equal numbers. In late May 1986, a bit up the Coonoor Ghat I found a roost of this species comprising some 300 individuals. None of a random sample of fifteen or so was *E. core* though they sometimes roost together. There is little difference in habits between the two common crows. The species is found in Sri Lanka and South India, then from Nepal to most of the Oriental region, the Papuan subregion and the Pacific.

150. **Euploea klugii kollari** Felder & Felder
(*Euploea crassa*)

The BROWN KING CROW is very much rarer in the Nilgiris than the two others and is much more closely confined to wet evergreen forests. I have taken moderate numbers only on the Nadgani Ghat and at Mukkali near the entrance to Silent Valley (1000 m). Hampson appears not to have found it, but Wynter-Blyth caught a few at Kallar where it is not normally found. Although it may easily be overlooked since it is much like the other two on the wing, the species does appear genuinely to be quite rare. The curved termen of the male forewing is very characteristic. All three *Euploea* may be caught together at Mukkali and Nadgani, and on a few occasions I have tested their pheromonal odours. All three were pleasant, but definitely different, though I will not venture to try a description. All are fond of flowers, but I have not taken *E. klugii* at water, though I will not rule out that it occasionally visits damp patches. The species is found in Sri Lanka, in South India, and from Nepal east to Indo-China and Sumatra.

(*to be continued*)

INTERSPECIFIC BEHAVIOUR OF THE GREAT INDIAN BUSTARD *ARDEOTIS NIGRICEPS* (VIGORS)[1]

Asad R. Rahmani and Ranjit Manakadan[2]

(*With seven plates*)

The Great Indian Bustard *Ardeotis nigriceps* (Vigors) lives in grassland, open scrub land and semi-deserts of the Indian subcontinent (Ali & Ripley 1983) along with a large number of species such as the blackbuck *Antilope cervicapra*, fox *Vulpes bengalensis*, white-eyed buzzard-eagle *Butastur teesa*, Indian roller *Coracias benghalensis*, black drongo *Dicrurus adsimilis*, etc. In its interaction with other species, the bustard shows fear of some, is antagonistic to others, and is neutral in attitude to a few. The species which are either feared/avoided/partially tolerated are termed here as 'non-associate species' while the animals which sometimes move with the bustard are termed as 'associate species'. Non-associate species are fox, vultures, eagles, crows and livestock while the associate species like drongo, roller, white-eyed buzzard-eagle, etc. are tolerated when they come very near to the bustard and even perch on it (as in the case of the drongo). This paper deals with the interspecific behaviour of the great Indian bustard with the animals found in its habitat. This study is a part of the investigation of the ecology, behaviour and present distribution of the great Indian bustard under the Endangered Species Project of the BNHS.

Study Areas: The main study areas were Nanaj in Solapur district, Maharashtra (17°41′N and 75°56′E, alt. 486 m) and Karera in Shivpuri district, Madhya Pradesh (25°30′N and 78°5′E, alt. 271 m). The Nanaj Study area consists of about five sq km of grassland, woodlot, grazing land and crop fields, while Karera consists of about 50 sq km of open scrub dominated by 50-60 cm tall *Zizyphus rotundifolia* bushes. This area forms a part of the 202 sq km Karera Bustard Sanctuary. The study period extended from September 1981 to June 1985.

Observations

A. Birds

a. non-associate species

1. *Vultures*

The Scavenger Vulture *Neophron percnopterus* appears to be the bird most feared by the bustard, especially the nesting hen. On many occasions we had seen female bustards frightened by scavenger vultures. For example, on 13 June 1982 at Karera, a scavenger vulture flew over the nest of a female bustard. Within seconds, the hen lowered her neck and sunk to the ground. After five minutes she slowly raised her neck, looked all around and then relaxed. Another encounter recorded was of a female bustard foraging alone on 19 June 1982 at Karera. A scavenger vulture landed nearby and the bustard hid among *Zizyphus rotundifolia* bushes as long as the vulture was in the vicinity. A large eagle,

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probably Tawny *Aquila rapax,* was also seen at that time in the area.

Other species of vultures are not so feared. On 7 June 1982 at Karera in the evening we were watching an adult cock bustard and a hen. The hen was foraging near her nest. At 1750 hrs two King vultures *Sarcogyps calvus* landed in the area to drink. At once the hen became alert and started walking towards the nest. Soon a Whitebacked Vulture *Gyps bengalensis* joined the king vultures. The hen stood near the nest and then settled down on the egg but soon got up and again stood near the nest, watching every movement of the vultures which were 100-150 m away. The hen later flew off towards the river to drink though the vultures were in the vicinity. After 23 minutes she came flying back and landed 600-650 m from the nest and as usual started drifting towards the nest while foraging. The whitebacked vulture flew over her head but no aggressive behaviour was seen. The hen settled on the egg and five minutes later both king vultures flew off, watched by the hen as long as they were visible. The cock bustard which was also in the area kept on displaying and remained unconcerned by the presence of vultures.

Though our observations are limited, it appears that the bustards are afraid of *Neophron* probably due to the vulture's well-known egg breaking habit (Alcock 1972). Bustards are not very frightened of the king and the whitebacked vultures as there is no potential danger from them to the egg or to the chick. McCann (1939) had seen scavenger vulture trying to break an egg of a flamingo (*Phoenicopterus ruber antiquorum*) in the Rann of Kutch. Recently Auffenberg (1981) saw an Egyptian (Scavenger) vulture using a stone to break the shell of a live turtle (*Lissemys punctata*). Apparently there seems to be more chances of predation of a bustard egg by scavenger vultures.

2. *Eagles and Falcons*

On a few occasions we have seen bustards being frightened by eagles. On 14 July 1982, for instance, at 1800 hrs a large eagle, probably Tawny settled on the ground in an area where two female bustards were foraging. Both hens reacted, one flew away for a short distance while the other stood alert with neck feathers erected in threat behaviour. We suspect that of the two bustards, one was a post-juvenile female following its mother and this young bird was more frightened. Soon both hens walked away from the eagle which looked exhausted and was being mobbed by a great grey shrike (*Lanius excubitor*) and a redwattled lapwing (*Vanellus indicus*).

On another occasion two subadult male bustards were slowly drifting towards three females when an eagle came flying from a nearby jheel and flew above the bustards. All the five birds flew off in different directions. The females landed together and the males landed nearer to each other. The eagle was probably an immature greater spotted (*Aquila clanga*).

Another interesting eagle-bustard interaction was seen in April 1984 in Karera. Appearance of an eagle scattered all the bustards from our study area. Though up to nine bustards were seen frequently in that area in April-May, as long as the eagle was present, only the territorial cock remained. One hen was on the nest when the eagle appeared for two days. On 1 May in the morning, we saw her sitting crouched on the nest throughout our three hours of observation. She did not leave for the usual foraging activity when the eagle was around. Dharmakumarsinhji (1962) has noted 'freezing' of an incubating hen bustard when an occasional eagle flew overhead.

We have observed an adult cock bustard boldly but unsuccessfully threatening an eagle *Aquila* sp. near a termitarium. On 2 August 1983, a subadult male bustard was seen eating white ants (alates) as they emerged from a damp hole in the morning. Bank (*Acridotheres ginginianus*), and common (*A. tristis*) mynas, Indian roller (*Coracias benghalensis*), crows (*Corvus splendens* and *C. macrorhynchos*) and drongo (*Dicrurus adsimilis*) were present around the bustard. The bustard was seen snapping the winged termites as they flew out from the hole. The tail of the bustard was cocked up in a fan shape, perhaps to threaten other birds. An adult cock then came over and chased the younger male away and started picking the alates. It also fanned its tail but only for a short time. The subadult male kept lingering around and soon the alates stopped emerging from that hole. Both the bustards walked away amicably and were joined by another subadult male. The adult male saw emergence of winged termites from a new hole and quickly went over and started picking the insects but kept the two subadult males away. Shortly thereafter an eagle landed and all the smaller birds scattered but the cock bustard moved only a few feet. The eagle started eating the alates and while the subadult males moved away the adult male vainly tried to threaten the eagle which ignored the demonstration. The cock then walked away and all three males flew and settled about 100 m where they soon found a new hole from which the alates were emerging.

A similar encounter near an active termitary was reported by Howells & Fynn (1979) between a Denham's Bustard (*Otis denhami*) and about forty Black and Yellow kites (*Milvus migrans migrans* and *M. m. parasiticus*), one Steppe Eagle (*Aquila nipalensis*), three Lesser Spotted Eagles (*A. pomarina*) and two Wahlberg's eagles (*A. wahlbergi*). The Denham's bustard was seen defending the ephemeral food source. When a kite landed at the termitary, the bustard ran towards it 'with wings raised', tail partially erect and neck craned forward ..... the kite was struck twice before escaping".

Though we do not have any direct evidence of an eagle killing a great Indian bustard, our observations suggest that the bustards, especially hens, consider eagles as a potential threat. Fraser (1982) found a Martial Eagle (*Polemactus bellicosis*) on a freshly killed adult Kori Bustard (*Ardeotis kori*). Some ten metres from the kill, another Kori Bustard was seen hiding in tall grass...." probably too frightened to move" (Fraser 1982).

Though falcons (mainly lanner *Falco biarmicus*) is occasionally seen at Karera and at Nanaj, we have not seen any encounter with the bustard. We think, there is no danger to an adult great Indian bustard from a falcon. Even trained falcons are seldom able to kill a great Indian bustard. Elliot (1880) wrote that falconers sometimes try to kill bustards with Peregrine (*Falco peregrinus peregrinator*) but they are no match for the bustard. "So rarely has the pursuit been successful that the Nawab of Banganapiliny (*sic*) in Cuddapah confered a village Inam (or free tenure) on a falconer who achieved the feat" (Elliot 1880).

3. *Owls*

Due to the temporal differences in the activity periods of the owls and the bustard, very few encounters were seen. The great horned owl (*Bubo bubo*) and the shorteared owl (*Asio flammeus*) are seen at Nanaj and we have observed one bustard-owl encounter with each species. On 14 August 1982 at 0550 hrs, a cock bustard was seen displaying (threat display?) near a rubble wall on which *Bubo bubo* was sitting. Both the birds were calling. Soon the bustard stopped displaying and

moved away. The owl flew and settled nearer to the bustard. The male again cocked the tail and started calling. In the dim light visibility was poor. The owl flew to its roost when the light increased.

The great horned owl is a formidable predator (Grossman & Hunlet 1965). Even remains of a peafowl have been found in its stomach contents (Ali & Ripley 1983). Though we have no direct evidence of a great horned owl killing an adult or young great Indian bustard, it is perhaps capable of doing this. Winterbottom (1962) has described that Townsend found a fresh-plucked Korhaan (*Eupodotis afroides*) ready for eating, in an old raptor nest from which he had shot a *Bubo lacteus.*

One interspecific encounter was seen between the bustard and the shorteared owl. In October 1983 at Nanaj at dusk before settling for roosting two young chicks of about 6-8 weeks old and three hens were frolicking. The chicks were jumping and exercising their wings. Suddenly a shorteared owl appeared and it followed the chicks who flew effortlessly and made a circle of nearly 200 m. The hens just looked at the owl and made no attempt to threaten it probably knowing that the owl can not harm the chicks who were slightly bigger than the owl. The owl also made no attempt to catch the chicks which slowly returned to their respective mothers. The bustards did not change the roosting site due to the appearance of the owl.

4. *Harriers*

Pale (*Circus macrourus*), Montagu's (*C. pygargus*) and Marsh (*C. aeruginosus*) harriers are quite common in winter at Karera and at Nanaj. At Karera, the harriers arrive in September when most of the bustard chicks have fledged so there is practically no danger to them from the harriers. At Nanaj, the harriers are present September onwards when the bustard chicks are still very small. Even then there appears to be no danger from the harriers due to the effective protection provided by the hen bustard to the chick. The bustards either ignore the harriers or at the most threaten them by partially cocking the tail. The harriers also generally avoid the bustards. On a few occasions we saw a juvenile bustard threatening a harrier which came near to it while its mother just ignored the raptor.

5. *Yellow-wattled Lapwing*

At Karera on the morning of 1st May 1984 a solitary female bustard was mobbed by two yellow-wattled lapwings (*Vanellus malabaricus*) when it came near their nest. The bustard was apparently unperturbed and it walked away at its usual pace. The lapwings were aiming at the head of the bustard. A complete egg of a quail (*Coturnix*) was recorded from the stomach of a great Indian bustard (Ali & Ripley 1969) so there are chances that it can also pick up eggs of a lapwing.

6. *Cranes*

Three or four pairs of Sarus cranes (*Grus antigone*) are resident in our study area at Karera. Sarus and bustards both feed in harvested wheat fields though not necessarily at the same time. However, in 1984-85 when we started baiting bustards with wheat near our hide, a pair of sarus was also 'hooked' to the bait and every morning they were seen eating the bait with the bustards. Similarly in a bengal gram (*Cicer arietinum*) field, both the species were seen together (Plate 1 A-B) and bustards were seen moving freely between the sarus without any agonistic behaviour. The male bustard appears to be more tolerant of sarus than a female.

Between September and December 1984,

about 400 Demoiselle Cranes (*Anthropoides virgo*) were seen at Karera. They used to fly noisily in flocks all over the area but very few encounters with bustards were seen. Once they flew over seven female bustards which just looked up and resumed foraging. In another instance, nearly 100 cranes landed in a groundnut field (*Arachis hypogea*) where ten bustards were foraging. After landing the cranes started feeding vigorously while the bustards appeared to be visibly uncomfortable and they kept looking at the cranes. Slowly all the bustards drifted away leaving the cranes in the field.

7. *Barheaded Goose*

During winter, more than 500 Barheaded Geese (*Anser indicus*) are found in our study area in a jheel at Karera. These geese greatly damage the bengal gram crop. The bustards are also very fond of this crop. Occasionally we have seen both the species feeding in the same field but the bustards were never seen walking in the middle of a flock of geese. By the end of winter in 1984, only one gram field was left unharvested which was grazed by the geese, sarus and bustards. Once we saw the three species feeding at the same time but not very close to each other. Generally, the geese and the bustards fed at different times in the same field mainly because the appearance of geese attracted the attention of the field owner while the bustards were tolerated by him. Therefore, few geese bustard encounters were noted.

8. *Crows*

Crows (*Corvus splendens* and *C. macrorhynchos*) are feared by incubating hen bustards and generally avoided by non-breeding females. According to Dharmakumarsinhji (1962) crows appear to be a constant menace to the egg. We suspect that one of the eggs in 1983 at Karera was destroyed by a crow. In the subsequent year we actually saw egg predation by a crow. On 11 April 1984 when a hen bustard had gone to drink water from a river. at 0725 hrs, a jungle crow saw the hard-set egg and pecked at it. When the hen returned she atonce started chasing the crow but the damage had already been done. For more than an hour, the crow was in the vicinity of the nest and was actively threatened by the hen. As soon as the crow landed, the bustard used to rush at it, beak widely open, wings drooping and sometimes, tail cocked. She was very agile in following the persistent crow. Many times the bustard jumped up to peck at the crow with the beak open as widely as possible. This went on for 8-10 minutes, then the crow flew away but returned at 0900 hrs, for a short while. In the evening, the hen bustard was roaming in the nest area and when she saw the crow on the nest, she came flying and aggressively threatened the crow. Thrice she jumped over the crow but could not catch the wily predator. However, she was successful in chasing the crow away. Next day the crow was not seen in the area though the bustard was seen in the vicinity of the destroyed egg. A crow can destroy a bustard egg only in the absence of a hen bustard because on many occasions we have seen a hen successfully chasing away a crow from the nest.

9. *Rock Bush Quail*

On 18 June 1985, we saw an adult bustard vigorously displaying to three rock bush quail *Perdicula argoondah*. The bustard was intentionally moving towards the foraging quails which soon disappeared in the bushes. This display lasted for about two minutes. When the quails disappeared the cock returned to its favourite spot in the arena and continued displaying.

b. ASSOCIATE SPECIES

Black drongo (*Dicrurus adsimilis*), white-eyed buzzard-eagle (*Butastur teesa*), redheaded merlin (*Falco chicquera*) and Indian roller (*Coracias benghalensis*) are the four birds often seen with the bustard. These four species greatly benefit by their association with the bustard as they eat the insects flushed by the bustard. This association falls under the classical case of commensalism. Commensalism is defined by Clarke (1954) as an "association (of different species) in such a way that only one of the organisms is benefited but neither is harmed". Feeding association occurs when a bird (or mammal) intentionally approaches another organism and thereby gains foraging advantage (Dean and MacDonald 1981).

1. *Drongo*

Between our two field stations, we have commonly seen drongo (*Dicrurus adsimilis*) associated with bustard in Nanaj but rarely in Karera. When we started our work in September 1981 in Nanaj, drongos were seen moving with the bustards. An additional development since 1982 is that the drongo has learnt to ride on the back of the bustard. This seems to be a recently acquired behaviour due to the change in the habitat. In 1981 most of the drongo-bustard associations were observed in a semi-woodlot plantation where there were many perches in the form of small saplings for the drongo to perch on. From 1982, the bustards were sighted more often in a pure grassland area where there were very few perches. In the absence of perches, the drongo started sitting on the back of the bustard.

The drongo at Solapur shows local movement. It is practically absent from the grassland in summer and early monsoon though some are seen near the villages and towns. We have kept a record of the first sighting of the drongo and first sighting of a drongo riding on a bustard:

Year	First sighting of a drongo in the study area	First sighting of a drongo riding on a bustard
1982	28 September	28 October
1983	5 October	24 October
1984	4 October	25 October

In 1982, the first drongo was seen in Nanaj study area on 28 September in a grassland plot with stunted Neem *Azadirachta indica* bushes of not more than 70-90 cm in height. Slowly their number increased. Exactly a month later on 28 October, a drongo was seen riding on a bustard. Soon this habit was acquired by most of the drongos. Due to lack of rains, movements of bustards in our study area was erratic (Rahmani & Manakadan 1986), but whenever bustards were seen they were followed by one or two or even more drongos. The drongo used to follow the bustards throughout their foraging period, sometimes even waiting near a resting bustard. For instance, one day a drongo sat on a bush near the resting adult cock bustard for 25 minutes before flying away. As soon as the cock became active again in the afternoon, a drongo was seen following it. Even if a bustard flew and landed in a new area, the drongos followed. Sometimes up to five drongos were seen with a single bustard.

A female bustard is more tolerant of a drongo sitting on her back than a male. Even a hen with a month old chick ignores a drongo following it. On 23 November 1983, we saw two hens together each with a chick and each with a drongo sitting on its back. Similarly a sub-adult male also allowed a drongo to sit on it. However, the adult cock bustard evidently finds it irritating to have a drongo sits on its

back. We have rarely seen a drongo sitting on the adult male bustard for more than a few seconds, while on females they sit up to five minutes at a stretch. As soon as a drongo alighted on a cock's back, it turns and shoos it off. Once in November 1984, three drongos were following an adult cock when one settled near the tail, the male gave a startled jump and on landing threatened the drongos by opening its wings, cocking the tail and erecting neck feathers, but the drongos continued to pester the bustard.

The sitting spot of a drongo on the back of a bustard also differs in the male and the female. On the adult cock, they generally sit (momentarily) on the rump but on a female or a subadult cock, they sit on the mantle or the back. This was markedly noticed in 1984 than in earlier years. Apparently this is an adaptation of the drongo to keep itself away from the beak of a pugnacious adult cock who generally looks back and tries irresolutely to peck at the drongo.

After settling in the grasslands of Nanaj for a few weeks, the drongos become so used to following the bustards that on 31 October 1984, when a dummy of a female bustard was put out to decoy a male, a drongo came and sat near the dummy for 15 minutes!

At Karera the drongo is a resident species but it is very rarely seen following bustards. Moreover, whenever we saw a bustard being followed by a drongo, the association was always for a few minutes and after a long interval. Sometimes this association was not seen for weeks or for months. Only once for a whole week a drongo was seen following a bustard every now and then. Unlike Nanaj, this association is not a long term one here. At Nanaj the drongos were such persistent companions of bustards that it became easy for us to locate a bustard just by searching for the drongos. All drongos were not necessarily near bustards, but all bustards had a drongo or two in attendance. Such type of persistent association was never noticed at Karera. Secondly at Karera we never saw drongos sitting on bustards probably because at Karera, the ubiquitous *Zizyphus rotundifolia* bushes provide a convenient perch so a drongo has no reason to sit on a moving bustard. At Nanaj also, most sightings of a drongo sitting on a bustard were in the grassland plot where there were hardly any bushes for perching. In the semi-woodlot plots or where a perch was available, the drongo preferred to use it while attending a bustard.

The first drongo-bustard association at Karera was seen on 2 June 1982, five days after we started intensive studies. A hen bustard was followed by two drongos and an Indian roller at 1755 hrs. The roller displaced the drongos and after about ten minutes both the drongos flew away.

The second such association was noticed after a year on 21 July 1983 when the drongo was seen following a female bustard for five minutes. After that no such association was seen for a couple of months though the bustards were watched daily. In 1984 on 8 June a drongo was seen following a hen with a chick for 40 minutes. The hen was not disturbed and she never threatened the drongo even when it came near the young chick. On another occasion we saw similar behaviour probably with another mother and chick.

Drongo-bustard association is purely commensal with the former as a beneficiary since the drongo(s) catches the insects flushed by the foraging bustard. Thus the drongo uses the bustard as a beater'. Occasionally the drongo(s) may actually compete with the bustard for the insects but generally it takes only those that are fast fliers and thus beyond bustard's capacity to catch.

It is difficult to explain the very casual

drongo-bustard association at Karera though both the species are resident and are seen in the same open-scrub area throughout the year, while at Nanaj, both the species have a local movement and they are seen in the grasslands mainly during the monsoon. If a drongo is equally benefited at both the places (i.e. Karera and Nanaj) by following a bustard, logically a more persistent association should be seen at Karera rather than at Nanaj because a resident population should learn and *retain* its experience of following a bustard if the experience is beneficial to it.

The answer possibly lies in the difference of habitat/vegetation between Karera and Nanaj. At Nanaj, there is a sudden increase in the population of insects after the rains and as the grass becomes almost uniformly tall, most of the insects in it lie hidden unless they are flushed out by some moving object. As there are very few perches in grassland from where a drongo can sally to catch flying insects, it is advantageous for this adaptable species to utilize a big bird like a bustard as a mobile perch which at the same time flushes numerous winged insects. On the other hand, at Karera the *Zizyphus* bushes and the occasional *Acacia leucophloea* trees provide innumerable perches for a drongo. Unrestricted livestock grazing also does not allow the grass to grow uniformly tall and leaves many open patches where detecting insect prey is easy. Moreover, the insect population (chiefly grasshoppers) reaches its peak in summer and early monsoon when spotting an insect from a convenient perch is apparently easier than from the back of a bustard whose movement to a particular area is unpredictable.

In Africa the feeding associations of the Carmine Bee-eater (*Merops nubicoides*) with the Kori Bustard have been documented (North 1944, Jackson 1945, Lynn-Allen 1951). Interestingly, the northern race of the Carmine Bee-eater has developed the habit of sitting on the backs of mammals and bird species (North 1944) while in the southern race this habit is not seen. Ali & Ripley (1983) have recognised two subspecies of the Black Drongo within the Indian limits: *Dicrurus adsimilis albirictus* in north India and *D. a. macrocercus* in the peninsula below the Tropic of Cancer. Like the Carmine Bee-eater, the drongo also shows some behavioural differences in its two subspecies, i.e. *macrocercus* has developed the habit of perching on a moving bustard while *albirictus* does not show this habit though it perches on other animals like cows, sheep and goats. However, we think this is more due to adaptation to the local conditions rather than any inherited subspecific behavioural difference.

2. *White-eyed Buzzard-Eagle*

The White-eyed buzzard-eagle *Butastur teesa* is another associate of the bustard. In Karera it is commonly seen in the monsoon months but with the arrival of winter it moves to other areas. Like a drongo or a roller, the buzzard also follows a foraging bustard but only at a distance.

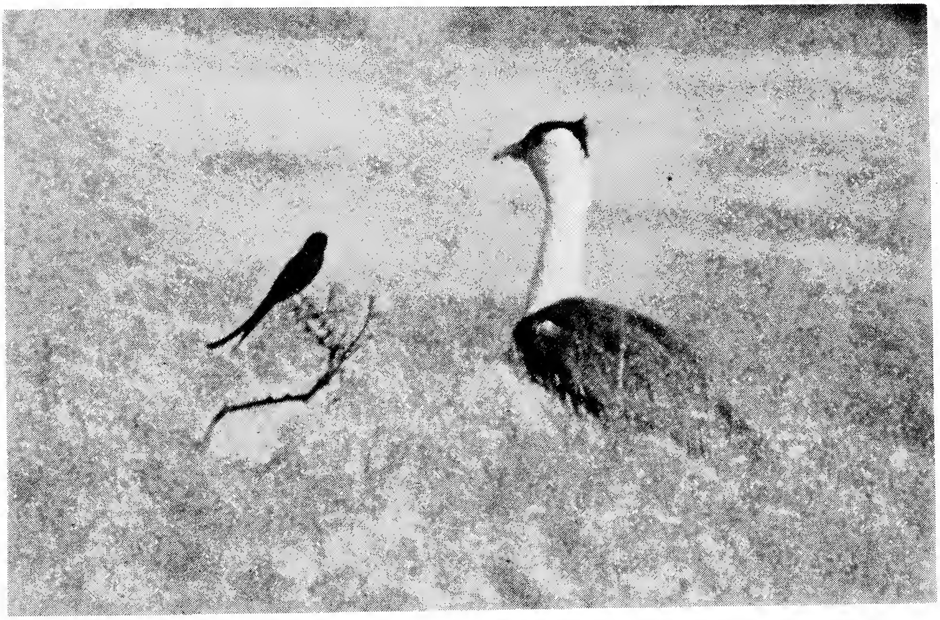
Buzzard-bustard association is more persistently seen at Nanaj than at Karera. The buzzards are so much benefited by the flushing of grasshoppers by the bustards that sometimes as many as four buzzards were seen together in attendance. For instance on 18 August 1982 at 0845 hrs. four buzzards were seen following a cock bustard at Nanaj. The same day at 1000 hrs. three buzzards foraged with the bustard. When the bustard sat down among a tussock of grass for resting, a buzzard came and sat near it for eight minutes, waiting for the bustard to get up and flush insects for it.

In 1983 and 1984 very few buzzard-bustard associations were seen at Nanaj. Moreover,

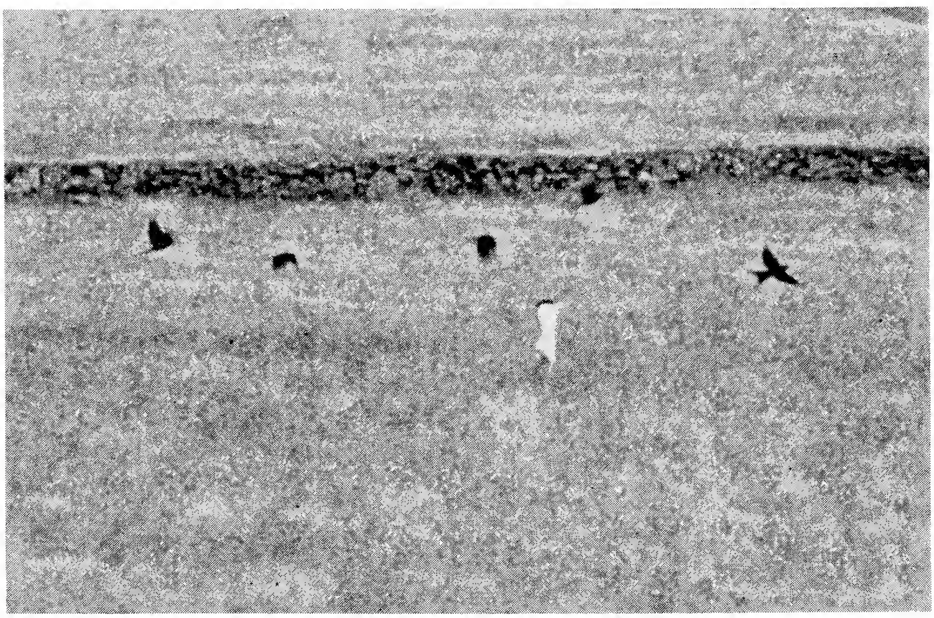
A. A male great Indian bustard with a sarus crane in a chana field.

B. A subadult male bustard moving inbetween a pair of sarus cranes in a chana field.

Photos: Asad R. Rahmani



A. Black drongos are often found in association with the bustards at Nanaj.



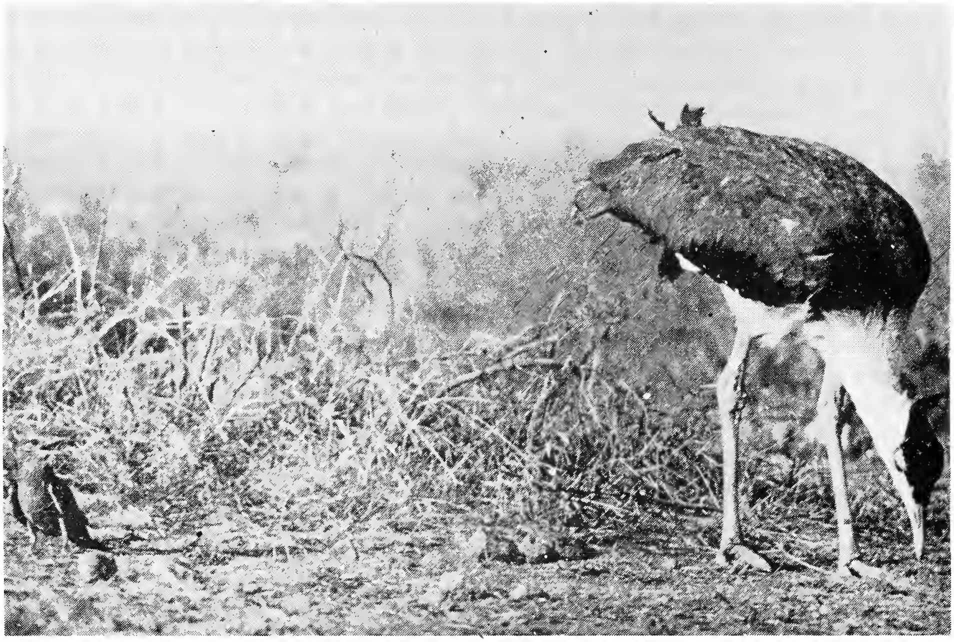
B. Five drongos following a male bustard.

Photos: Asad R. Rahmani

A. An Indian roller following a great Indian bustard.

B. An Indian roller sitting very close to foraging bustards.

Photos: Asad R. Rahmani



A. An Indian roller expectedly waiting near a bustard for an insect to be flushed.

B. An Indian roller waiting on a bush close to a foraging bustard.

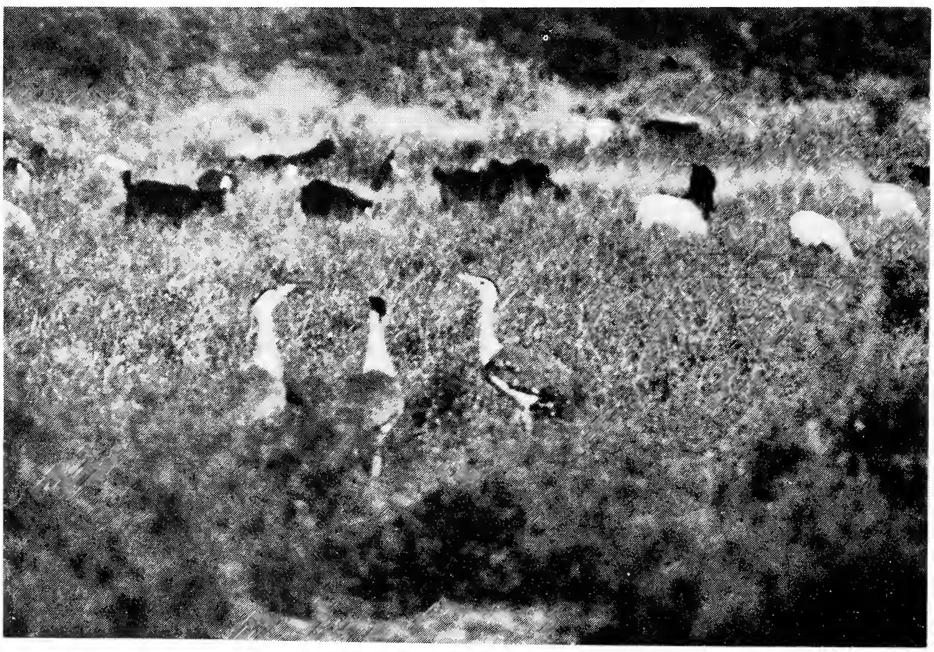
Photos: Asad R. Rahmani

A. A pair of common myna following two female bustards.

B. The same pair of myna near another female bustard.

Photos: Asad R. Rahmani

A. A young female bustard walking away from a blackbuck.



B. Three female bustards alerted by a herd of goats.

Photos: Asad R. Rahmani

A. An adult cock bustard being disturbed by cows.

B. A hen with a post-juvenile male chick moving away from a herd of goats and a goatherd.

Photos: Asad R. Rahmani

most of these associations were seen with the adult cock, perhaps because we watched that male most frequently, possibly also because a cock bustard is more tolerant of the presence of a small raptor compared to the timid females.

3. *Redheaded Merlin*

The redheaded merlin (*Falco chicquera*) is present at both the Nanaj and Karera field stations and was seen by us in many other bustard areas as well. But a merlin-bustard association was seen only at Nanaj in 1982. On 29 July 1982, for the first time we saw a merlin following the adult territorial male at Nanaj. Even when the cock flew to threaten another adult cock the merlin followed it. It shows the persistency of the bond. During two hours of observations on that day, the merlin caught an insect flushed by the bustard thrice. Soon another merlin joined in and for some time both merlins followed the foraging bustard much like drongos.

Merlins were seen again on 7, 12, 14 and 18 August. Unlike drongo the merlin generally sat in front of the foraging bustard chiefly on the numerous stone heaps. Here again the adult male bustard appeared to be more tolerant of the merlin then the hens. On 14 August, for example, four bustard females were seen foraging together attended by a merlin. Twice the merlin flew near a female and she threatened it. The same merlin flew towards a cock who was displaying on seeing the hens, but when the merlin found the male not moving (except for the display movement) it flew back to re-join the foraging females who were clearly flushing grasshoppers from the tall grass.

Once we saw both a merlin and a white-eyed buzzard-eagle following an adult male bustard who was foraging in a new sunflower field. The buzzard was sitting on top of a mound while the merlin was flying ahead of the foraging bustard. When the bustard approached the mound, the merlin came back and flew low over the head of the sitting buzzard who momentarily lost its balance but did not budge. The merlin was trying to sit on the mound because that was the only spot which gave a clear view of the area. Undeterred the merlin settled on the ground in front of the bustard. Soon an insect was flushed by the bustard and it was quickly snapped up by the buzzard in the air. After a short while, the merlin flew away but the buzzard followed the bustard for some more time.

By the end of September 1982 the merlin was not seen with the bustard as they had moved out locally. We did not see any merlin-bustard association in 1983 and 1984 at Nanaj. No such association was ever observed at Karera.

4. *Indian Roller*

The Indian roller or blue jay *Caracias benghalensis* was seen with the bustard quite frequently at Karera but only once at Nanaj. On 5 July 1984 at Nanaj, a roller followed two hen bustards and a young male for sixteen minutes in the morning (Plate 3). Many times the roller caught grasshoppers flushed by the bustards. Such an association was not seen in earlier years. However, at Karera we noticed this commensalism as soon as we started our work there in May 1982. Between May and July, the roller was seen following bustards on five occasions. But from September when we resumed our studies at Karera till the end of March the roller was never observed with the bustard though it was present in the area. From 29 March 1983 onwards this association was started again. A roller-bustard association is not as permanent as between drongo and bustard. For days

together we would not see any roller with a bustard, then a day or two both the species would be seen together.

The absence of a roller-bustard association between September and March could be explained by the fact that during this period the insect, especially grasshopper, population was very low so the roller found following a bustard unprofitable as hardly any other big insect was flushed. As soon as the number of grasshoppers increased by the end of March, the rollers resumed their association with the bustards.

Similarly in 1984, though the first roller-bustard association was noticed on 16 February, when a roller was seen following three males for half an hour, many more sightings were recorded after the first week of March when the insect population had gone up.

Like a drongo or a buzzard, a roller is tolerated by an adult bustard even when it comes to within a metre (Plate 3, B). Once a roller was seen trying to snatch an insect from the beak of an adult cock bustard. The roller was also commonly seen following a mother with a juvenile male chick, the latter used to frequently threaten the roller. On 6 April, we saw a roller following a hen with a ten-day old chick. The hen was not much disturbed by the proximity of the roller to the chick. The same day we saw another roller sitting beside an incubating hen waiting for her to get up and flush insects. We have seen the same behaviour with the drongo and with the white-eyed buzzard-eagle.

The roller appears to be less agile in catching fast flying insects than a drongo, a buzzard or a merlin. Rollers generally pounce on insects disturbed by the bustard. Thus, they generally sit on top of a bush close to the place where the bustards are foraging (Plate 4, A,B). The roller also changes its perch less frequently in comparison to the three species mentioned above. Only when a bustard has gone quite far (100-200 m) does it fly to catch up with the foraging bustard. The buzzard and the merlin are more persistent followers of a bustard, mainly because they have to catch a flying insect in the air before it is again lost sight of in the vegetation. Rollers prefer to sit on top of a bush so as to scan a wider area. The smallest movement of an insect on the ground is detected and the prey is pounced upon.

5. *Common Myna*

We have only a few observations of Common Myna *Acridotheres tristis* associating with the bustard. All these cases were mainly seen at Nanaj in 1984. On 22 June a pair of mynas were seen following a female bustard in the morning (Plate 5, A) but they soon flew off to their nest. At 0730 hrs two mynas (probably the same pair) were sighted with the adult cock bustard in the same area.

Myna-bustard association was again observed on 29th morning when a myna was seen following three female bustards for three minutes (Plates 5, B). Then it flew towards the nest in which we suspected chicks. Later the same morning twice we saw a myna with the female bustards, each time after catching a big grasshoppers it flew towards the nest. On 3 July, nine mynas were seen associated with three female bustards. Like drongo, buzzard, roller, myna-bustard association was purely commensal with mynas profitting by catching insects flushed by the big bird.

B. Mammals

Blackbuck, chinkara, wolf, jackal, fox and mongoose are (or were) present in almost all the bustard areas. In most of the places, the wild animals are complemented or more commonly replaced by a large population of domes-

tic animals like cow, buffalo, sheep and goat. The bustard frequently comes across these animals and reacts positively (tolerates/ignores) or negatively (moves away/threatens) depending upon the nature of the species encountered. We have kept a record of all the mammal-bustard interactions and the results are given below.

I. WILD MAMMALS

1. *Wolf*: Adult great Indian bustard has presently few natural enemies. Though there are no records available of the Indian cheetah *Acinonyx jubatus* (now extinct) hunting bustards, it could perhaps have been the bustard's predator when both the species were common. The wolf *Canis lupus* has also become rare. It is present in highly depleted numbers both in Nanaj and Karera. The wolf is greatly persecuted by shepherds at Karera so it has become almost nocturnal and extremely stealthy. Nevertheless, we saw wolves atleast ten times in four years but no interaction with the bustard was noted.

At Nanaj, four wolves were frequently sighted and we saw three interactions with the bustards. On 14th August 1982, for instance a wolf was seen chasing blackbucks in the morning. Adult blackbucks were not very afraid and reacted by just trotting away. An adult cock bustard was foraging in the area. The wolf saw the bustard and chased it for a short distance. The bustard who was already alert by now, flew and settled nearly 200 m away and resumed foraging as if nothing had happened. The wolf did not continue the chase and vanished into a gully.

A few days later, a wolf (probably the same) was seen chasing a sub-adult blackbuck in the same area in the late evening. The terrified antelope and the pursuing wolf made a complete circle of the study plot where we were present, and when the displaying adult cock bustard saw the fleeing blackbuck it stopped displaying and when the wolf came near it, the bustard flew away after pooking and settled on a ridge in the open grazing land. It roosted there. We suspect that it changed its roosting place from the grassland to the open, stony bare area so that it could easily see approaching danger (wolf) at night.

In 1983 at Nanaj, four wolves were frequently sighted in our study area and we think that one female bustard was lifted from the nest by a wolf because one morning we found lots of feathers scattered around the nest and no trace of the hen. A day earlier, two wolves had been sighted in that area. Incidentally, the predator (wolf?) had not touched the egg which was present on the nest.

Though it is very unlikely that a wolf can catch the usually alert adult bustard during the day, it is a potential predator of a roosting or nesting bustard. One of the reasons the bustard's roost in the bare area is that they can see a ground predator.

2. *Jackal*: The jackal *Canis aureus* is present both at Karera and at Nanaj though at the latter place, we saw it only once and we have no observation of jackal-bustard interaction. However, at Karera the jackal is relatively more common and we observed three encounters of bustards with jackals. On 5 November 1982 at the end of the day, four hens and a hen with a post-juvenile male chick were seen at 1745 hrs in open bare area preparing to roost. The mother and chick were in a nearby fallow field. A pair of jackals appeared and two of the females became alert and started moving towards the jackals. Soon they were joined by the remaining two hens. The mother and chick stopped preening when they saw the jackals and the hens mobbing

them and they also started to walk towards the jackals who were slowly trotting along the bare area. Soon all the six birds caught up with the jackals and chased them. The jackals quickly disappeared into the scrub. While chasing, all the birds appeared to be very confident-even the young male was ahead of its mother in threatening the jackals. When the jackals had disappeared, the birds relaxed and returned to their respective roosts. Before roosting, they frolicked for few minutes. The mother and chick returned to the same spot in the fallow field from where they had started.

After a month, we were watching the four females and the hen and chick. Suddenly all the birds became alert and stood motionless. Four jackals appeared about 20 m from the birds but ignored them. The females, however, flew and settled about 300 m away but the mother and chick remained motionless and when the distance between them and the jackals increased, resumed foraging.

The third encounter was also seen in the evening. On 30th April 1983, three hens were foraging in the *Zizyphus* area. At 1845 hrs when two jackals appeared about 200 m from the birds they became alert for a few minutes but soon resumed foraging. This time also the jackals ignored the birds. These incidents suggest that adult bustards are generally not afraid of jackals.

3. *Fox*: The fox *Vulpes bengalensis* is very common in Karera, less so in Nanaj. The adult bustard is not at all afraid of the fox. Often we have seen foxes moving in the same area where the bustards were feeding but the birds just looked at them and resumed foraging. Bustards were rarely seen to change their course of action after seeing a fox. On the other hand we have seen the birds threatening if the fox came close to them. For example, on 7 August 1982 in Nanaj, the adult cock was in full display at 1855 hrs when a fox appeared near it. It stopped displaying and threatened the intruder by spreading its wings and erecting the neck feathers. The fox ran, followed by the bustard for a short distance.

We saw one interesting fox-bustard encounter at Karera on 7 March 1984. A hen and a post-juvenile male chick were foraging. The chick was still being fed by the mother. At 1845 hrs we saw the mother walking briskly, followed by the chick. In front of them was a fox walking away from the annoyed birds. The bustards were purposely chasing the fox and were walking very fast. The neck feathers of the birds were erect. When the fox disappeared, the birds relaxed. The chase was seen for a little more than hundred metres. Later, the birds roosted in the same area.

Though a fox is not a danger to a healthy adult bustard it is a menace to the egg. We saw one bustard egg being preyed upon by a pair of foxes when the hen had gone for foraging. On 13th April 1984 at Karera, in the early morning when the hen bustard was foraging about 200 m away from the nest, the unattended egg was discovered by two foxes who atonce started eating it. Simultaneously, the hen saw the foxes, she came running and started threatening the predators. The foxes started running round and round the *Zizyphus* clump followed by the angry bustard. After a few minutes of futile chase, the hen returned to the nest, stood there for some minutes, and slowly picked up the scattered egg shell pieces and carried them some 32 m away from the nest site. The foxes and the bustard were seen throughout the day in the nest area.

4. *Mongoose*: Two encounters with a common Indian mongoose *Herpestes edwardsi* were seen in Karera under different circumstances

and thus showing contrary results. On 7 October 1982 three male and two female bustards in sex sub-groups were foraging in the open scrub area with the females walking about 30 m from the males. An adult mongoose appeared in between the two sub-groups. A female threatened it with open wings and erect tail. The mongoose went on its way and the birds resumed foraging. The males who probably had not seen the mongoose showed no reaction.

Female bustards with egg or a young chick are very frightened of mongooses. For example, on 30 March 1983, in Karera a large mongoose was seen near the nest of a bustard. The hen which was foraging nearby first froze when she saw the mongoose, then she started walking in a hunched posture towards the nest. Later she squatted down and we saw her moving on her tarsi. The mongoose was searching about 20-30 m from the nest. When the mongoose went away, she slowly got up and sat down on the nest. She was panting and it took a few minutes for the hen to relax even after the departure of the mongoose.

When a hen bustard is on her nest she is capable of defending but when she is away foraging or for drinking, then the bustard egg is in a great danger of being preyed upon by a mongoose.

5. *Blackbuck and Chinkara*: Blackbuck (*Antilope cervicapra*) and chinkara (*Gazella gazella*) are present in Karera. Though they are not the enemies of the bustard, we have seen bustards threatening them or walking away from the antelopes, depending upon the circumstances and the proximity of these animals. As a rule bustards do not bother either blackbuck or chinkara unless they come very near. According to Morgan-Davies (1965) in Tanzania, kori bustard attend blue wildebeest (*Connochaetes taurinus*) and feed on small mammals disturbed by them. We have never seen any great Indian bustard following the antelopes to feed on the disturbed insects.

In Nanaj between 400 to 500 blackbucks are present. We have many times seen a female bustard threatening an inquisitive fawn or a nervous doe. Once a 3-4 month old fawn was threatened four times by a female bustard when the young antelope persisted in following her.

Due to an abnormally high population of the blackbucks at Nanaj (compared to the size of the area, i.e. about five sq km), blackbuck-bustard encounters are frequent and we have often seen bustard suddenly finding themselves amidst a big herd of the antelope. On many occasions, the adult territorial cock bustard at Nanaj was seen walking towards blackbucks or continuing display even among a passing herd of blackbucks.

The blackbucks have become so numerous in our study area at Nanaj that they are perhaps now a danger to the egg of the bustard. In 1983, one egg was probably trampled by a blackbuck which used to sit near the nest. We found the broken egg with a fully developed embryo a few centimetres from the nest as if someone had kicked it. Up to 200 blackbucks were seen in that study plot. The male buck which used to sit near the nest on its own midden had frequent territorial fights with other passing males and we suspect that during one such fight the egg was inadvertently kicked while the hen was away foraging.

II. DOMESTIC ANIMALS

In most of the bustard areas, a very large number of domestic animals like cow, buffalo, sheep and goat are present. The main danger from these animals is the destruction of habitat by over-grazing and trampling of egg. Here we will discuss only the domestic animal-bustard interactions.

1. *Cattle*: The Cow is the most numerous

domestic animal in Karera and Nanaj. Bustards generally do not go near a grazing herd and if the cows move toward a foraging bustard, it briskly walks or flies away. At Nanaj in 1983, an adult male was trying to establish its territory on a ridge. However, that ridge was on the path of the cows which used to disturb the cock while returning to the village. After three or four such disturbances, the male finally abandoned the area.

At Karera on numerous occasions we have seen bustards being disturbed by cows (Plate 7, A). However, we think the chief cause of disturbance is not the cow *per se* but the cowherd who generally accompanies the animals. Nevertheless, unlike the blackbuck herd we never saw a bustard moving inbetween a herd of cows even when the cows were not accompanied by human beings. Smithies (1946) reported that a pair of Stanley bustard (*Neotis denhami*) were often seen together with cattle and were probably feeding on disturbed insects. We never saw such type of behaviour in the great Indian bustard.

Reaction of a bustard to a buffalo is similar to that of a cow. Bustards scrupulously avoid going near a buffalo herd, especially when a cowherd is present. Once at Karera in 1984, we saw 12 unaccompanied buffaloes grazing close to a nest. The hen bustard was vainly trying to chase away the buffaloes but with no effect. The egg was saved from getting trampled by our intervention. One buffalo came as close as two metres of the egg.

2. *Goats and sheep*: Probably due to their smaller size, goats and sheep are tolerated by a bustard if the goat-herd is not present (which is very rare thanks to the wolves in the areas). A few times we saw bustards becoming alert when the goats/sheep came near them (Plate 7, B) but they flew off only when the goat-herd appeared on the scene. Once when a goat-herd was prevented from going near the alert birds, the bustards relaxed and started foraging very close to the goats. This proves that the bustards are not disturbed by the goats/sheep but by the goat-herd. Once we saw an incubating female bustard getting up from the nest and threatening a few goats. However, she ran and hid when the goat-herd came near. Mr. J. P. Rogers (quoted by Mathews 1913) has seen similar incidents with the Australian bustard (*Ardeotis australis*). Once he saw a hen "with widely expanded wings, confronting the sheep, and with croaking noises trying to keep them from the vicinity of the eggs".

C. Reptiles

The monitor lizard (*Varanus benghalensis*) is one of the major threats to the egg of the bustard when the hen is not near the nest. For example, on 12 June 1982, a hen bustard was foraging around the nest at 0825 hours. A big (75-100 cm) *Varanus* appeared nearly 40 m from the nest. At once the hen came and threatened the monitor, forcing it to run away.

The same day in the evening at 1819 hours, the same hen got up from the nest to threaten a monitor lizard (probably the same). After successfully chasing it, she came back to the nest and stood near it for a minute, then settled down on the egg very tightly when the lizard appeared again. In Nanaj in 1983, we suspect that one bustard egg was preyed upon by a monitor lizard which had a hole close to the bustard nest.

Among snakes, we have seen cobra (*Naja naja*), striped keelback (*Amphiesma stolata*), saw-scaled viper (*Echis carinatus*), Russell's viper (*Vipera russelli*), common Indian krait (*Bungarus caeruleus*) in Karera and/or in Nanaj. On four occasions we saw a bustard eating a small snake but we did not see any

encounter of a bustard with a big snake. Probably the bustard avoids them.

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BREEDING OF POND-RAISED HYBRIDS OF MAHSEER FISH, *TOR KHUDREE* (SYKES) AND *T. TOR* (HAM.)[1]

S. N. OGALE[2] AND C. V. KULKARNI[3]

First generation hybrids between *Tor khudree* and *T. tor* do mature even in small ponds in oxygenated water and with special feeds. Gravid specimens of these fish can be stripped and eggs fertilised successfully without the use of pituitary hormone injections. *T. tor* can also be bred similarly.

INTRODUCTION

Depletion of stocks of the mahseers all over India is well known, and different methods for their rehabilitation and conservation are being considered. Experimenting with various methods of breeding the fish has therefore, assumed considerable importance for conserving the mahseer resources of our country. Several authors had in the past drawn attention to this problem.

In recent years (1970), concrete steps for artificial propagation and rehabilitation for conservation of the Deccan Mahseer, *Tor khudree* were taken at the fish seed farm of Tata Electric Companies at Lonavla (Maharashtra), thanks to the foresight of Shri S. Moolgaokar, who visualised the problem and initiated the efforts. As a result of these studies, Kulkarni (1971) gave a preliminary account of the spawning habits, eggs and early development of the fish, including a method of stripping the spawners. The report of the Agricultural Commission of the Government of India (1976) also emphasised the need to conduct biological and ecological investigations on the life history of different mahseers. These recommendations encouraged such studies on *Tor putitora* in the Kumaon and Garhwal regions of the sub-Himalayan tracts (Pathani 1982, Das 1978 and Nautiyal 1985) and on *Tor tor* near Hoshangabad on the Narmada river (Desai 1970). Tripathi (1978) attempted breeding *Tor putitora* by stripping on a small scale, while Kulkarni and Ogale (1978) elaborated the method of artificial propagation of Deccan Mahseer, fertilising more than five lakh eggs every year since 1974. However, as the method of collecting ripe spawners for stripping has its limitations, efforts were made to breed mahseer successfully by hypophysation method (induced breeding) with the help of pituitary hormone injections at the Lonavla fish farm and the particulars have been detailed by us earlier (1986). However, since further simplification in breeding methods of this fish was desirable, fresh experiments were undertaken and the results are recorded in this paper.

Limitations of the stripping method: Stripping the spawners (male and female), artificial fertilisation of eggs and their rearing afterwards are the conventional methods followed extensively in Europe, America, Japan, etc., especially in the case of Salmon and Trout. However, the collection of ripe and oozing spawners is the crux of the problem. In the case of the salmon, this becomes possi-

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ble because of its very distinct migratory habits for spawning, provision of suitable fish ladders and the consequent concentration of population of spawners in small areas. In the case of mahseer, such detailed study is yet to be accomplished and collection of mahseer spawners continues to be a problem. In Walwhan and Shirawta lakes where Kulkarni and Ogale (1978) had conducted most of their studies, the spawners could be collected because of special environmental conditions which were favourable for the purpose. Both these lakes are surrounded by hills and the rain water running through the small ravines formed temporary streams which cascade into the lakes at certain points in the marginal area. These streams form torrents when the rainfall is heavy and create a mild fluatile condition in that part of the lake. Consequently, gravid fish which are attracted by the sound of running water and its high oxygen content, follow their breeding instinct but being unable to ascend the forceful streams, keep on milling in the shallow marginal area of the lake. In this condition, some of them re-absorb their reproductive products, while some release them on a small scale and breed. the rate of survival of the young being very poor. If fishing is done in this area with the help of gill nets or large cast nets, ripe spawners can be caught and used for stripping. But in many of the mahseer streams seen by the senior author, such favourable situations do not prevail and gravid fish keep on migrating into small streams which are very much dispersed in the forest area. resulting in dispersal rather than concentration of the breeding population. Collection of spawners for stripping thus becomes a problem and sometimes disappointing. Breeding of the fish in farm ponds, therefore, assumes greater importance.

Raising and breeding of hybrids

The impression prevalent so far has been that like the commercial carps such as Catla, Rohu etc. the mahseer also would not breed naturally in farm ponds. Hypophysation was, therefore, considered essential. This method was tried for mahseer in the Lonavla fish farm and had proved successful (see Kulkarni and Ogale 1986). However, a search for simpler method of breeding mahseer by improvement of environment such as running water, exercise, better feeding and then stripping the gravid fish was considered promising and attempted successfully.

Incidentally the farm had a stock of hybrids between *T. khudree* and *T. tor.* In 1982, gravid specimens of *T. khudree* collected from Walwhan lake were stripped and 2000 ova were cross fertilised with semen of *T. tor* raised in the fish farm. Fertilisation was almost cent percent. About 90% eggs hatched out and the resultant fry and fingerlings were then grown in a separate pond. The hybrids of this first generation showed characters intermediate between the two species concerned and the rate of growth was almost similar to that in both.

During the monsoon of 1985, both sexes of the stock appeared to be unripe. However, improvement in gonadial development was achieved both with age as well as special feed and exercise. In early August 1986, two females were stripped and 3,500 ripe ova obtained and fertilised with semen of *T. khudree.* Fertilisation appeared complete but the hatching rate came down to 70%. The effort was repeated on October 18, 1986 when five females were stripped. One of them gave bad eggs with their perivittaline membrane ruptured. This was probably the result of the ovary being in a state of resorption. The remaining four females gave 5,200 ova which were again

fertilised with semen of *T. khudree* without administration of pituitary hormone injections to either sex. The rate of fertilisation was slightly lower. being about 95%. The eggs were hatched in the usual hatching trays (Kulkarni & Ogale 1978) but at this time the water temperature was 24°C and ambient temperature 29°C. As expected, the hatching time was reduced to 50 to 60 hours. However, the mortality rate went up to 50% which was much higher than in the case of females caught directly from the lake. No evident reason for this high mortality could be given but the possibility of better results if the efforts were made in the earlier month cannot be ruled out when the climate was cooler. However, the hatching rate improved to 90% and the fry and fingerlings were healthy and active as usual.

Special care of the brood fish: The brood fish which were used for experimentation were stocked in a small rectangular pond 10 m × 25 m and a depth of 1.2 m, along with other major carps, such as Catla, Rohu, Mrigal etc. The special care of the brood fish consisted in using a feed additive of 3 nitro (3 nitro-4 hydroxyphenylarsonic acid), a 5% premix in the usual feed of groundnut cake and rice polish 1:1 ratio. This works out to 1 gm of premix per kg. of feed and this feed was given at 3 to 4 p.c. of the body weight of the prospective brood fish. Further, the fish were given exercise by netting the pond once or twice a week from January to June. A small 4 cm wide pipe provided constant running water to the pond. These conditions represent the minimum requirements for the growth of the gonads and these cannot be said to be very specialised and difficult for any fish farm.

Our recent efforts indicate that pure *Tor tor* can also be stripped and bred in a similar manner. In *Tor tor* the method is more fruitful because they mature in ponds even in April. Such mature fish were examined and stripped in April 1984 in a lake, Telcosagar, near Pune. With such early maturity, three trials can be taken with each pair of fish and a sufficient number of eggs obtained.

Conclusion: Maturation of gonads and stripping of eggs and their successful fertilisation without use of pituitary or any other hormone in *T. khudree* and *T. tor* have great significance in mahseer breeding and its conservation. Fecundity in these experiments was found to be comparatively low, put these results provided a proof that mahseers can be raised in pond and bred, thus creating a dependable source of fry and fingerlings for stocking depleted waters. Second finding is that the mahseers can be easily hybridised and the resultant progeny is likely to have useful characters but this would need extensive research and observation. Further, what is true in the above two species is likely to be true in the case of other species of mahseers also, but this too needs actual trials.

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FEEDING BEHAVIOUR OF FREE-RANGING RHESUS OF TUGHLAQABAD[1]

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Numerous primate studies show food as a key ecological variable, influencing social behaviour and population dynamics. A long term study showed, that although the rhesus of Tughlaqabad spent an average of only 2.34 hours daily, feeding and foraging which constitutes 17.5% of their day time activity, which is rather less as compared to other studies, yet their feeding behaviour affected their many other activities. The Tughlaqabad monkeys consume three types of foods, 1) food provided by humans, 2) natural food in the terrain, 3) agricultural crops. Of the 45 different species of food plants consumed by them, only 24 constituted a significant intake. Of these 24, 9 were leaves, pods and fruits of trees and rest 15 were agricultural crops. 59% on an average, yearly, of their feeding time was spent on food from human and 41% on foraging for natural foods and crops making the results rather unique. The time spent on foraging on a particular day depends upon the availability of food from visitors. It was seen that the activities of rhesus of Tughlaqabad are governed by one major component of the ecosystem namely, the human population. Thus evidently groups modify their feeding behaviour markedly, depending upon specific habitat and environmental conditions.

INTRODUCTION

The purpose of the present study has been to employ quantitative field techniques to study the feeding patterns of the free ranging rhesus population of Tughlaqabad. In the absence of any long term study at Tughlaqabad, the present work has necessarily been exploratory and of a rather general nature. Hopefully, it provides a comprehensive backdrop for future studies that focus on more specific problems and relationships.

Relatively few studies of rhesus feeding behaviour have been done in India, and none in a habitat like Tughlaqabad. Lindburg (1975, 1976) and Neville (1968) studied the food habits of rhesus groups around Dehra Dun and Haldwani feeding primarily on natural forest vegetation. Siddiqi and Southwick (1980) studied the food habits of roadside groups in an agricultural habitat north of Aligarh. Tughlaqabad offers the most diverse of these habitats in that it contains forest patches, agricultural fields, pastures, and a public archaeological site.

The habitat exerts a profound influence on the successful use of field techniques. There are many advantages of studying this group of monkeys as it is not a confined colony but yet has almost all the advantages of a semi-protected population. Good visibility provides an opportunity to acquire information relating to spatial relations and both interspecific and intraspecific social relations amongst the animals; the presence or absence of territoriality, the extent of home ranges, night sleeping quarters, and utilization of available resources. Since the components of the ecosystem change seasonally, and from year to year, and the

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weather varies annually, data have been collected during 5800 contact hours over 3 breeding seasons. Such a longitudinal study programme allowed examination of seasonal or other periodic variables and their influences on group activities. This longitudinal study also helped to investigate the influences of various personalities upon critical roles in the group, such as the differences in the diet of different age and sex classes and reasons behind it. Thus an attempt has been made during the study to examine the relations between social organisation and ecology. The techniques used to collect data on various activities and population dynamics of rhesus monkeys of this area were Goodenough's Time Sampling method (1928), Smith's Scan technique (1968) and Sampling all occurrences of some behaviours (Rowell 1967). The population and habitat at Tughlaqabad have been described in previous papers (Malik, Seth and Southwick 1984, 1985).

Background

Many primate studies have shown food as a key ecological variable, influencing social behaviour and population dynamics. Both field (Chalmers 1968) and laboratory studies (Zimmerman *et al.* 1973) have demonstrated that a large proportion of aggressive interactions occur as a result of competition for food. Play which requires "surplus" energy, decreases as the amount of available food decreases (Altmann 1959, Loizos 1967). Increased availability of food produces a decrease in day range because the group does not have to travel far to secure sufficient food (Altmann and Altmann 1970, De Vore and Hall 1965, Crook 1966). Hall (1963) postulated that groups which spend less time foraging, spend more time engaging in social activities especially grooming; similar propositions have been advanced by Crook (1970) and Rowell (1972).

Under a constantly abundant food supply, an increase in population size has been noted among the provisioned colonies of Japanese macaques at Takasakiyama (Itani *et al.* 1963, Itani 1975) and the rhesus macaques at Cayo Santiago (Koford 1965b). Conversely, in a food limited population of *Macaca sinica,* the survivorship of infants and juveniles has been reduced, and the population has remained stable (Dittus 1975, 1977). The diversity of food consumed by each primate species has not been evaluated, due in part to great differences in observational opportunities to tally the number of plant and animal species eaten by the group under study (Jolly 1972).

The extent to which animals select a particular food can be estimated by dividing the amount consumed by the availability of the food in that environment (Clutton-Brock and Harvey 1976). Several studies have calculated selection ratios for particular foods by dividing the proportion of time spent feeding on the 'natural vegetation' by some measure of the relative availability/abundance of the vegetation (or, in some cases, the relative abundance of the canopy cover they provide). The larger the cover, the greater the availability of the food (Clutton-Brock and Harvey 1976, Struhsaker and Oates 1975).

Nutritional analysis of diet and the energy costs of activities have only recently begun to figure in primate studies (Coelho 1973). Detailed accounts of feeding behaviour for the 12 or 13 species comprising the genus *Macaca* have been published only for *Macaca sinica* by Hladik and Hladik (1972).

Struhsaker and Oates' (1975) estimates of the time spent consuming different foods by red colobus were very similar to those obtained in the neighbouring troop by Clutton-Brock and Harvey (1976).

Marriot (1978) reported that the rhesus monkeys of Kathmandu spend 10.5% of their

day time in feeding based on a comparative study of the food supplied by humans and the naturally available food. Her main interest was in the type of food eaten, amount consumed and nutritional content of the food. Taylor (1975) observed that the temple monkeys of Kathmandu obtained 68% of their overall diet from worshippers and the remaining 32% from natural sources. Teas (1978) found that feeding changes from being the second most predominant activity in the summer to the most consuming activity in the fall. Shrestha, Malla and Majupuria (1980) reported monkeys eating nettle grass during the solar eclipse in 1980. Feeding behaviour of the rhesus monkeys of Swayambhu (Nepal) have also been studied by Bajracharya (1979).

Macaca mulatta frequently eats earth in small quantities (sometimes taken from termite mounts) (Blanford 1888-91, Roonwal 1956, Mandal 1964, Mukherjee and Gupta 1965, Lindburg 1971, Puget 1971, Krishnan 1972). Drinking behaviour of *Macaca mulatta* in India has also been studied (Mukherjee 1969, Mukherjee and Gupta 1965 and Mandal 1964).

Results

Feeding plays one of the most important roles in determining the daily routine. Although the rhesus of Tughlaqabad did not have to spend long hours in foraging, an average of only 2.34 hours daily constituting 17.5% of the daytime activity, nonetheless their feeding behaviour affected many other activities. The priority of feeding was illustrated by the observation of a mating pair who terminated the bout to obtain food from a visitor. Even after eating, mating was not resumed. The animals sat close for a short while and then went in different direction.

The Tughlaqabad area provides rhesus monkeys with a wide range of food. The vegetation found in the area is xerophytic and subtropical. Crops are grown in adjacent fields. The monkeys consume three types of food: (1) food provided by humans, (2) natural food in the terrain, and (3) agricultural crops. The food provided by humans is fairly consistent, almost ritualistic, but it comes in greatest abundance on Tuesdays and Saturdays. This does not change much seasonally; only, as the summer days are longer and daylight hours are more the people have more time to feed the monkeys. Thus the monkeys spend 10% of their time during summer on food given by humans, slightly more than 9% during the winters. The food provided by nature and agriculture varies more seasonally: (1) when crops have been sown and trees bear fruits (January, February), or (2) when crops have been harvested and trees bear no fruit (May and November). In the first instance, when the monkeys have not had enough food provided by man, they fall back upon the natufal food. In the second instance, even nature does not provide food in abundances, so they spend more time foraging, i.e., 11% in the month of May as compared to only 6.5% in the months of March, September and December. Thus the dietary pattern is variable and adaptable at different times of the year. The peak of the feeding time on any given day is between 9 A.M. and 11 A.M. during winters and 8:30 A.M. to 10:30 A.M. during summers. This is the period when the animals either are fed by the humans or have waited long enough to be fed by humans, and if they are not fed, resort to the natural vegetation. The other period of equally intense feeding is in the evening between 3 P.M. till 5 P.M. during winters and 4 P.M. during summers.

The rhesus of Tughlaqabad were observed to consume 45 different species of food plants,

but only 24 of these constituted a significant intake. Of these 24, 9 were leaves, pods and fruits of trees, and 15 were agricultural crops (Table 1). These numbers do not include the variety of foodstuffs provided by people which ranged from chapatis to eggs and mutton patties or similar picnic items. The natural vegetation was certainly not as diverse as the forests available to the monkeys in Lindburg's study, where they were observed to eat portions of more than 100 species (Lindburg 1975, 1976). It was, however, more diverse than the tree species available to the rural monkeys in the study of Siddiqi and Southwick (1980) where

TABLE 1

NATURAL AND AGRICULTURAL FOODS IN THE TERRAIN

Local Name	Botanical Name	Part Eaten	Energy in Kilo Calories
	ON TREES		
Babul (Desi kikar)	*Acacia arabica*	leaves and pods	
Date Palm (Khajoor)	*Phoenix dactylifera*	fruit	144 fresh
Gum Tree (Kikar)	*Acacia arabica*	leaves and pods	
Indian Jujube (Ber)	*Zizyphus jujuba*	all but the seed	158
Margosa (Neem)	*Azadirachta indica*	tender leaves	158
Peepal	*Ficus religiosa*	figs	110
Oak	*Quercus incana*	fruit	
Siras	—	leaves and pods	—
Sissoo (Shisham)	*Dalbergia sissoo*	leaves and pods	—
	IN FIELDS		
Brinjal	*Solanum melongena*	leaves & fruits	40 & 24
Cabbage	*Brassica oleracea*	leaves	27
Cauliflower	*Brassica oleracea*	leaves & stalk	66
Carrot	*Dancus carota*	leaves	77
Chari (Jowar)	*Sorghum vulgare*	leaves	349
Lima beans	*Vigna catjang*	leaves	290
Maize	*Zea mays*	grain & leaves	125
Masoor	*Raphanus sativus*	leaves	28
Methi	*Medicago falcata*	leaves	—
Mustard	*Brassica acampestris*	leaves	34
Peas	*Pisum sativum*	leaves & pods	315
Radish	*Raphanus sativus*	leaves	28
Spinach	*Spinacia oleracea*	leaves	26
Turnip	*Brassica rapa*	leaves	67
Wheat	*Triticum aestivum*	Grain, stalk & leaves	341

Quantitative food requirements are usually estimated in terms of heat units calories. A physiological calorie (also called Kilocalorie and abbreviated Kcal*) is the amount of heat necessary to raise the temperature of one kilogram of water by one degree centigrade and this heat unit is different from the physical heat unit which is one-thousandth of the physiological calorie. This is an amount of food having an energy-producing value of one large calorie.

* also known as the large calorie.

only 4 species of native trees were available in addition to mango and guava.

The Tughlaqabad rhesus spent 41% of their feeding time on natural vegetation on the yearly average, and 59% of their feeding time on food provided by humans (Table 2). This differs from the Chhatari group of Siddiqi and Southwick where only 7% of the feeding time was spent on natural vegetation, 10% on agricultural crops, and 83% on direct handouts from people. In the Sumera Fall rhesus group near Aligarh, however, 53% of the feeding time was on natural vegetation, 17.5% on agricultural crops, and only 29% on food directly from people. Thus rhesus groups seem to modify their feeding behaviour markedly depending upon specific habitat and environmental conditions.

TABLE 2

DISTRIBUTION OF TIME BY ACTIVITY IN DIFFERENT SEASONS

Average	seasons	Eat natural vegetation	Fed by humans	Drink
percentage	Winter	07.30	09.00	02.00
time spent	Summer	08.49	10.00	04.71
per day	Annual	07.99	09.50	03.35
Average	Winter	00.88	01.08	00.24
hours	Summer	01.02	01.20	00.56
per day	Annual	00.96	01.38	00.42

Acquisition of New Food Habits and Adaptability: The rhesus monkeys here wait to get food from the local people or visitors before plundering the vegetation of the area. The Tughlaqabad monkeys' diet is composed of vegetable food, though at times they have been observed scrounging and sucking eggs from food baskets brought there by picnickers. Other than eggs, the rhesus monkeys of all age groups, and both sexes have rejected all types of non-vegetarian food. An adult was observed catching a cockroach, smelling and rejecting it, which was later taken up by a juvenile who also rejected it after smelling. Juveniles are more exploratory with food and acquire new food habits more easily than the adults. At one time a fruit with a hard shell (Bael-*Aegle marmelos*) was cracked by a visitor and thrown in pieces to the rhesus monkeys. The first piece was grabbed by an adult female who smelled the fruit and rejected it. But the rejected piece was taken by a juvenile of about 7 months who ate the fruit after smelling and tasting it. The bael was probably rejected by the adult as she had had enough food and did not want to risk experimentation, or adults are by nature more rigid in their food habits than juveniles.

Acquisition of new food habits are related to the amount of food available at a time. At the time of food scarcity even adults eat the food they had refused to eat at a time when surplus food was available. Supporting this is the instance of a female adult rejecting a mutton patty after sniffing it. When a juvenile tried to pick up the rejected patty it was cuffed by the adult and forced to leave it alone. But approximately two hours later, during which she did not get anything to eat, at a different spot, when the same adult female was given

a patty she sniffed it and tasted the bread and proceeded to eat the bread but rejected it when she reached the meat inside the patty.

The diet of the rhesus monkeys of Tughlaqabad also includes bark, seeds, cereals, fruits, vegetables, leaves, earth and buds. On just one occasion an adult male was seen eating bird droppings. This was the only occasion when such a behaviour was observed.

Posture: The most usual feeding method involves sitting on their haunches conveying the food to their mouth by hand and biting off the desired morsel. The hand engaged while conveying the food is mostly the right hand, though at times they use both hands together or alternatively. When extremely hungry or in danger of being attacked by the others, a rhesus monkey will gobble down the food rapidly. At times when food is plentiful for all, or a rhesus monkey feels safe from attack by others, it will eat the food slowly, seeming to 'relish' each bite. When there is scarcity of food, the monkeys have been observed scraping the inside of banana peels leaving just the thin membrane. A rhesus monkey was observed licking banana from the road where it had been dropped by another.

The other method employed while feeding is to stand on their hind feet, using forepaws to pick food from the ground and conveying it straight to the mouth, alternately with each paw. The feeding can be intense, relaxed or lazy. Intense when they are eating both their favourite foods and are very hungry. Relaxed when there is no threat of any danger and when they may be hungry. Rhesus monkeys of Tughlaqabad have been observed lazily eating wild fruits, grass and leaves.

Processing: The rhesus monkeys have been observed on numerous occasions, dusting the food picked from the ground before it is conveyed to the mouth. This they usually do with food they eat without peeling; for example, chappatis, bread, biscuits, apples, chikoos, etc. Certain foods need special preparation before being consumed. For instance, the shell surrounding the peanuts is first removed with the incisors and the nut is eaten. The skin of the mango is first peeled with the incisors and the hands and the fleshy pulp is eaten by scraping the fruit with the incisor teeth. The skin of the banana is likewise stripped before being eaten, first half the length, the other half may be discarded or eaten, depending on how full the monkey is.

Rhesus monkeys eat grass blades by plucking them with the right hand and conveying them to the mouth. They break small pods of sheesham by pressing the pod against the teeth with the hand and then consuming them.

Food Preferences: The rhesus eat and relish fruits, which are also eaten by human beings. Bananas are fed most often, hence their fondness for the fruit. But they also eat other fruits like apples, chikoos, and tomatoes with as much fondness as bananas, when given. The second food preference is the food prepared by humans, like chappatis, bread, rusks, biscuits, etc. Lastly, they prefer the wild fruits, leaves, pods and crops of the area.

These preferences are relative: related to the extent of their hunger. On the other hand when they are very hungry and resort to the vegetation of the area for nourishment, they eat the natural food just as intensely as they eat bananas or biscuits.

Interaction with Human Beings: Rhesus monkeys at Tughlaqabad at times greedily pounce upon food even before it is offered to them. At one instance, some visitors had brought bananas for the monkeys in a car. Before the bananas were taken out of the car, monkeys pounced upon the food greedily grabbing as much as they could carry. At other times, they do not come near the man handing out food. And yet at other times, they

are apprehensive to start with, testing the intentions of the giver before they eagerly approach him in swarms demanding their share by tugging at his pant or shirt, and climbing on to him. But will not snatch the food from his hand and will wait for their turn, eager yet not hostile if they know the giver and he is firm. They only threaten visitors who come to give the food if they are threatened first. Pirta (1984) has also described the behaviour of rhesus in taking food from people.

Foraging: Foraging behaviour is affected by age, sex and social rank of the individuals. This is illustrated by the fact that a dominant animal consistently fed to the exclusion of subordinates in those regions where food was most abundant. Subordinate animals often had their food usurped. In times of general food scarcity when foraging time in all age classes had increased, the order of least time spent but most food consumed, was most marked and evident. Adult males spent the least amount of time in food foraging, then adult females followed by juvenile males. The most time spent in foraging was by juvenile females. As to the quantity, it was not easily observed on a day when food was in abundance, i.e., a Tuesday. On Tuesday, 13th May, 1980, four known active healthy individuals were the focal animals. All food items and their rates of consumption by these four focal animals were recorded every minute. The individuals were followed from 5.30 A.M. till 7:30 P.M. The data thus collected revealed that dominant males get the maximum calories, followed by the dominant females (Table 3). The lowest or poorest food was consumed by the juvenile females. The subordinate animals approached the food only after the dominants had had their pick of the food while they fed on the leftovers, also the dominants were the first to pounce upon the food given by the visitors.

TABLE 3

FOOD CONSUMPTION IN RELATION TO AGE AND SEX CLASS[1]

Age & Sex Class	Bananas	Channa peanuts & other seeds	Chappatis	Leaves, shoots & herbs	Wild fruit	Total calories consumed
Adult male	12	22.5 Gms.	2	—	4	2196
Juvenile male	6	35 Gms.	1	$\frac{1}{4}$ handful	10	1235
Adult female	7	40 Gms.	1	$\frac{1}{2}$ handful	25	1449
Juvenile female	4	50 Gms.	$\frac{3}{4}$	1 handful	33	1115

[1] During 14 hrs. of 1 day, from 5:30 a.m. to 7:30 p.m.

Use of Buccal Pouches: Buccal pouches are used on two occasions: (1) when there is surplus food and the rhesus monkeys want to store the food to be eaten later. For example, when being fed by human beings and when they do not want to waste time chewing the food, the food is gobbled down to fill the buccal pouches to be eaten later at leisure, (2) at a time when there is threat of the food being snatched by the dominants, it is stored in a hurry to be eaten later, e.g., on lean or normal days when visitors offer food to the juveniles, they store it immediately in pouches without looking at the dominant adults around.

Intra-group Relationship While Feeding: The infants are a privileged class in the group. The attitude of the other members of the group towards the infants is one of tolerance. The

male adults tolerate from them what they would not tolerate from juveniles. For instance, while feeding, the leader is the first one to approach to take the food and the one who tries to precede him is severely punished, but not so the infants. An infant, however, may take a morsel even out of its mother's hand and eat. This way the infants learn to recognise the food. Having eaten what the mother eats, the infant learns the taste and smell of the food. The mother would not permit this of an older offspring. For example, when any attempt is made by a juvenile to take the food from the mother, the juvenile is snarled at, but not so the infant. The leader at one instance bit a juvenile on the neck when it tried to take food before he could take food.

Spacing Mechanism: When eating intensely on the food given by humans no spacing mechanism is ever observed. While raiding farms or cultivated plots each individual including the dominant males and females, subordinate males and females, and juveniles eat with a space of 2 or more feet separating them from others. Time to time they look up to survey their surroundings. Anyone violating the empty space has a fight on its hands. Frequent threatening and at times even biting occurs.

Threats: The majority of threats occur during foraging. A threat during foraging has several effects: (i) it prevents an animal from approaching another engaged in foraging, (ii) it causes the respondent to sit still and cease feeding while a dominant feeds nearby, (iii) usually it displaces the subordinate. The usurpation of food by dominants from subordinates is sometimes carried to the extent of snatching it away from its hand. Normally this occurs during a period of general food shortage.

Fights occurring over food do not start in the customary fashion, i.e., with a warning of any sort. Unlike territorial fights where the monkey threatens, shows its teeth and chest, assumes a very alert stance, etc., fights over food begin abruptly and end likewise. The offender is pounced upon before one knows what has happened. The quickness with which a rhesus monkey will pounce upon food before the leader, tends to save it from punishment and the loss of its food. The difference in getting away with offending the leader and getting caught is the speed with which they move. At one instance, food thrown for the leader was approached by a juvenile whom the leader caught, and bit on the neck. But while the leader was punishing this one, another juvenile hastily took the fruit away. Fights over food are of a very short duration, involving the offender and the offended alone.

There are two consequences of aggression between adults. Either the challenge is taken up and fighting occurs or the threat is ignored, which results in pacification of the aggressor and eventual repose. Fights occurring within a group never involve everyone of the group, but when fighting erupts, for a moment all group members are alarmed, including small infants.

Attitude Towards Senile Female: The senile female that lives among the rhesus monkeys of Group 'A' at Tughlaqabad is totally ignored. She is not threatened but neither is she allowed to feed among the other rhesus monkeys of the same group. She will either wait till all have eaten and then feeds on the leftovers. If a person feeding the monkeys spots her, she is thrown a fruit, but even the fruit especially thrown for her is sometimes grabbed by the others. She herself stays aloof from the others and never tries to compete with the others for food.

Farm Raiding: The rhesus monkeys at Tughlaqabad have ample opportunity to raid cultivated fields. As the fields are situated away from the village it is not possible for the

villagers to protect their plots at all times. The rhesus monkeys usually go into the fields in the evening, usually in large numbers, and at times as many as 120 animals are together in an area of 2-3 acres. It is interesting to note that at the time when this observation was made (1980) there were only two groups in the area and the total membership of the two groups was 120.

While feeding in a cultivated plot, there is no apparent sentinel to watch for impending dangers. The animals, while eating, will look up every few seconds to survey their surroundings. If any animal spots anything threatening it will immediately give a high pitched call to warn the others of the dangers, whereupon they all flee.

While raiding farms, the rhesus monkeys eat wheat by bending the stalks and prying the grain loose, either with their fingers or with their incisors. They will leave only the bare stalk (there is no wastage). At times they even eat the stalk. After a raid at the farm all that remains to be seen is just bare sticks where once there had been wheat.

Recognition of Food: Most rhesus monkeys locate and recognize their food mainly by sight. Odours of ripe fruits attract them occasionally. When they recognize the food by sight they do not smell it, but if food is given that they are not familiar with, they will first sniff it and then proceed to eat it or reject it, depending on their choice. For example, when given a green onion for the first time, it was sniffed by an adult female and only then did she eat it and seemed to enjoy it. In case of a tomato, it was not sniffed but was eaten with the smacking of lips and lingering over it as if to prolong the experience with obvious relish. A piece of candy wrapped in a bright wrapper, when given to a sub-adult male, was first stripped off the wrapper, sniffed and eaten with such relish that he refused a banana offered later on and was content to just sit where he was and smack his lips. The other members who watched him were tempted and many came down from the trees to examine the wrapper, one even went so far as to put it in his mouth, but spat it out when he realised it had no taste.

Rhesus monkeys not only recognize the food but recognize the visitors as well who have fed them on earlier occasions. Certain cars which come regularly to feed them are instantaneously recognized by these monkeys. It is evident from the fact that even before the vehicle has stopped and the food is offered to them, they start moving towards it in large numbers.

Rhesus monkeys are usually never hostile or afraid of visitors who come to feed them periodically. They will go right up to the person, extend one hand, tug at his pant with the other hand asking for their share. Even when the man stamps the ground with his foot to shake them loose, they do not threaten him but converge upon him again once he starts giving out the food. But sometimes monkeys are apprehensive of strangers who bring food for them.

A oooonnnnhh (sounding like the mewing of a cat) type of call is given by members of the group as soon as they recognize or suspect that food is anticipated, thus informing other members of the arrival of food. On hearing this call the whole group converges upon the vehicle or the people.

Drinking and Water Requirements: Drinking is clearly predictable as there are two sources of water available to them. One is from the leaves and juicy fruits. The second is the direct water source.

During winters most of the water requirements seem to be met by consuming leaves and juicy fruits. Time spent on drinking is only 2%. In summer, because not sufficient

water is available (for, even natural water sources dry up) they spend more time (4.71%) looking for drinking water. Little direct drinking behaviour was witnessed in the early part of March. However, towards the end of March and from April onwards, direct drinking was observed, and at times, even three or four times a day, each time a majority of the animals drink.

We have seen the rhesus monkeys drinking at all hours of the day. At times, even at 6:00 A.M. shortly after waking up the rhesus monkeys have been observed drinking water. There is no relationship between troop spacing or numbers and availability of water. At times, large groups comprising over hundred animals gathered at one place may space their drinking over a long period, interrupted by bouts of playing and eating. They lean on their forelegs and dip their snouts in water and suck through their lips for 2-3 seconds, lift their heads sharply, look around and then dip their snouts again if they need more. After one has finished, other rhesus monkeys drink in the same way as the one before.

This is the only method observed while the rhesus drink water. Hands were never used to facilitate drinking water, except on one occasion on 15th April (1980). One adult male used his right hand to clear the water surface at least 5 times before he finally drank water by dipping his mouth the usual way. At times even 10-15 rhesus monkeys have been observed dipping their mouths in water not individually but all at the same time. Rhesus monkeys frequent the village pond, the tubewell, the drain and the well for their requirements of water though they readily drink from rain water puddles when available. At times of acute scarcity rhesus monkeys explore the whole length and breadth of their territory for fresh sources of water, even if it is dirty water collected from construction work (as on 23rd

TABLE 4

DISTRIBUTION OF TIME BY ACTIVITY IN DIFFERENT MONTHS

	Eat Natural Vegetation		Fed by Humans		Drink	
Months	A	B	A	B	A	B
January	00.84	07.00	01.08	09.00	00.18	01.50
February	00.84	07.00	01.08	09.00	00.18	01.50
March	00.78	06.50	01.08	09.00	00.24	02.00
April	01.08	09.00	01.20	10.00	00.69	05.80
May	01.22	11.00	01.20	10.00	00.84	07.00
June	01.14	09.50	01.20	10.00	00.85	07.10
July	00.81	06.80	01.20	10.00	00.78	06.50
August	00.99	07.60	01.20	10.00	00.24	02.00
September	00.78	06.50	01.20	10.00	00.24	02.00
October	01.08	09.00	01.20	09.00	00.30	02.50
November	01.20	10.00	01.08	09.00	00.36	03.00
December	00.78	06.50	01.08	09.00	00.24	02.00

A:— Mean No. of hours/Day

B:— Average percentage Time

April they moved to Adilabad in search of water and had water from a pit at the construction site).

When foraging for water, the leader takes the whole troop but when ample water is available to them in their core area no one leads. The adults get priority over the sub-adults and juveniles if they happen to reach the water hole at the same time. And if the sub-adults and juveniles do try to be the first ones, the adults chase them away with threats and baring of the teeth.

Adults were never observed playing with water, but juveniles and infants have been observed jumping, splashing and swimming, at times chasing each other in or around water. On one occasion the mother patted her young infant (2-3 weeks old) as a signal to move, thus discouraging it from fooling around with water. Juveniles and adolescents were never discouraged.

Discussion

The rhesus monkeys of Tughlaqabad spend 20% of their waking hours in the trees and the rest 80% on the ground, i.e., in the fort, its surrounding pastures and cultivated fields and around the tomb. About 17% of the day-time is spent in active foraging for food and 3.3% for water. The time spent on foraging on a particular day depends upon the availability of food from visitors. For instance, when food is provided in abundance by visitors, monkeys spent more time on other activities and when there were too few visitors to offer the food then the time spent on other activities decreased, as they spent more time on foraging. Southwick (1962) found that rhesus spent approximately 10% of their waking hours in feeding, based on his study of the temple population in Aligarh. Altmann (1962), on the other hand, in his study of rhesus macaques reports that a maximum of 80% of their time is spent on foraging, which is far higher than 17% of Tughlaqabad monkeys. The time spent on feeding at Maroth is almost the same as that of the Tughlaqabad monkeys (Ojha 1982).

The activities of rhesus of Tughlaqabad are governed by one major component of the ecosystem, namely, the human population. In light of the above, it would not be wrong to support the theory of Shukla, Seth and Seth (1982) that pattern of activities are based on the components of ecosystems. Presuming that the components of ecosystems affect the various behaviours, it is understandable why the results/findings of the present study are different from others.

Tughlaqabad monkeys are known to have rejected all types of nonvegetarian food except eggs which they steal from food baskets brought by picnickers. Koford (1965a), during his study of an island colony of rhesus monkeys, reported the animals frequenting bird's nests, but there are no other instances reported of the monkeys eating eggs. Lindburg (1971), on the other hand, noted the rhesus monkeys in the forest of Dehra Dun ate termites, grass hoppers, ants and beetles. Rhesus juveniles were observed eating earth in small quantities on at least seven different occasions during this study. Blanford (1888-91), Roonwal (1956), Mandal (1964), Mukherjee and Gupta (1965), Lindburg (1971), Puget (1971) and Krishnan (1972) have reported rhesus eating earth frequently in their studies though they do not mention any particular age or sex class. Yet during this study, it was specifically noted that the earth-eating animals were juveniles less than 2 years of age. This did not occur during any particular month or season but was observed at different times of the year. Though a monkey was observed eating bird droppings, no record of such a habit has been reported

by others. Since this was observed on only one occasion, it was difficult to determine the reason.

During the summer months rhesus monkeys have been observed drinking water even at 6 A.M., that is, shortly after waking up, followed by drinking at least 4 or 5 times a day from rain puddles or nala in the field area. Mukherjee (1969) observed the rhesus monkeys of U.P. to drink stagnant water 2 or 3 times a day from the roadside ditches. On the other hand, rhesus monkeys in the mangrove forest studied by Mandal (1964) were never seen drinking water. According to Mukherjee and Gupta (1965), rhesus monkeys of mangrove forests obtained water by licking dew from leaves, by eating succulent leaves and long juicy blades of grass. The rhesus monkeys of Tughlaqabad met their water requirements in a similar way. Oppenheimer (in press) in his study of *Presbytis entellus* reported 68 plant species eaten by two troops over a period of 19 months in Jalaghata and Apurbapur Study area. Whereas in Tughlaqabad only 45 plant species comprised the diet of the monkeys. Besides, they also got a major portion of their diet from cooked human foods.

It has been observed that though the monkeys eat eggs, but perhaps due to some inner sense they do not eat meat even when offered. Because the rhesus monkeys obtain food often from the visitors or else from the natural vegetation they perhaps never had the necessity to eat insects and ants etc.

The eating of earth at all times of the year is a phenomena that is not easily explained. There seemed to be no particular reason for the animals to be eating earth. One thinks of hunger, but it is already evident that food is in abundance and such drastic measure need not be adopted to satisfy it. Likewise, earth eating is observed in young children as well, the rhesus monkeys observed eating earth were juveniles, this could perhaps be due to their playful mood, or to some special nutritional need.

The animals under study were healthy and well fed. As a consequence, only two cases of sick individuals have been observed during the entire study.

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IMPACT OF THE FOOD AVAILABILITY, NESTING-HABITAT DESTRUCTION AND CULTURAL VARIATIONS OF HUMAN SETTLEMENTS ON THE NESTING DISTRIBUTION OF A COASTAL BIRD, *EGRETTA GULARIS*, IN WESTERN INDIA[1]

R. M. Naik and B. M. Parasharya[2]

(*With seven plates & five text-figures*)

The nesting distribution and location of ninteen nesting colonies of the reef heron, *Egretta gularis*, in the Gujarat State of India, are described. The numerous bays, estuaries and swamps in Gulf of Kachchh and extensive tidal mudflats in Gulf of Khambhat are highly favoured by the herons for feeding. Much of the rocky and sandy coast of the western and southern Saurashtra is not favoured by the herons, but, they occur wherever there are tidal creeks and estuaries. In Gulf of Kachchh, the mangrove swamps still exist on numerous tidal islands, and the bird breeds there rather than on the mainland. Elsewhere on the shores, the mangroves are degraded or eliminated so that the bird breeds in the trees on dry land in human settlements. The coastal human communities predate on birds, so that the safe nesting trees are fewer in small coastal villages and towns. In large cities where a majority of the people protect the nesting birds, there are many safe trees for nesting. Where there is no coastal city around a rich feeding ground, the bird turns inland where a cropland, or a city, may provide ample safe nesting sites.

Introduction

At one time, the mangrove forests on the coast of Gujarat State provided the tree-nesting coastal birds a natural site for nesting. The large scale destruction to the extent of virtual extirpation at times, of mangroves for cattle fodder, firewood and timber during the present century, resulted in an important loss of the nesting habitat, so that the coastal birds have taken to nesting on trees in human settlements (Parasharya and Naik 1983). The cultural environment of a human settlement that determines whether it would be safe for the birds to nest there, varies regionally; this has added another dimension to the factors determining locations of the colonies of tree-nesting birds in the region. The present paper illustrates an interplay between an important nesting requirement, proximity of the feeding area, with the other nesting requirement, safeness of the nesting site ensured or denied by the human settlements, in determining the nesting distribution of a colonial tree-nesting bird, the Indian Reef Heron, also called Western Reef Heron, *Egretta gularis* on the coast of Gujarat, India.

The reef heron is found on the coasts of West Africa and Red Sea and western coasts of the Indian Ocean (Ripley 1982). The heron, which is polymorphic with respect to its plum-

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age colour ranging from dark grey to pure white (Naik and Parasharya 1983) and occurs in the coastal regions, is ecologically separated from its pure white close relative the Little Egret, *Egretta garzetta,* which occurs inland. The nesting distribution of the reef heron is poorly known (see, Naik *et al.*, for a review, 1981) and it was thought that the bird "possibly migrates locally to special areas" to breed (Ali and Ripley 1968). This paper, therefore, also represents a first serious attempt to study the nesting habitat preference and distribution of the reef heron in a part of its range in India.

Materials and Methods

Gujarat State, where the present studies were conducted, is divided for geographical and historical reasons into Gujarat, Saurashtra and Kachchh (Kutch) regions; the Gujarat region is further divided into northern, central and southern parts (Fig. 1).

Several representative coastal areas of Saurashtra and South Gujarat (Fig. 1) were surveyed during the heron's breeding season from March to September (see, Naik *et al.* 1981) mainly during 1980 to 1983. Wherever we found a nesting colony, we visited that area more than once in most cases and thoroughly surveyed a large area around the nesting colony. The nesting trees, number of nesting pairs, extent of nest predation and feeding habitats of the nesting birds were observed and recorded. We made observations on the proportion of different morphs of herons at the nesting colonies and nearby feeding grounds, and also on the breeding behaviour and feeding techniques, but, we hope to present those observations elsewhere.

We have had the occasion to re-visit some of the study areas outside the heron's breeding season as well, and we took these opportunities to look for the bird's roosting sites.

Observations

Gulf of Kachchh and northern coast of Saurashtra

Gulf of Kachchh bounded by Kachchh on the north, Saurashtra on the south and Little Rann (Desert) on the east, opens in the Arabian sea (Fig. 1). The gulf has an average depth of 30 m and an irregular coastal configuration with a number of islands, creeks and bays (Shrivastava and John 1977). Many tidal islands close to the gulf coast are covered with mangroves, and the reef heron is a common bird here throughout the year.

We have not looked for the heronries on northern coast of the gulf, but Ali (1954) has recorded a breeding colony on a tidal island in Kandla creek, near Kandla. We visited several places on the southern coast, namely, Jodia, Jamnagar, Sikka (16 km northwest of Jamnagar) and Okha (Fig. 1) and areas of the mainland around these places, but, failed to find any nesting colony of the heron. This was so, despite the fact that we have seen a large number of reef herons feeding in the coastal estuaries and inland waters in the non-breeding season. On the other hand, we have received several authentic reports of the herons breeding on some of the islands such as, Chusna and Sona Miya (Lavkumar, Personal Observations) near Okha in the Gulf. Pirotan is one such island where the birds are reported to be nesting. We could not visit this island during the peak period of breeding, but visited it from 8 to 10 March just about the time nesting started in 1980. Our several other visits to the island were made in the winter.

Pirotan is a tidal island which is connected by a land bridge to the Pirotan swamp and Saurashtra coast during the low tides (Fig. 2); the Pirotan swamp supports mangroves in various stages of degradation. On the northern side of the island, there is a lighthouse and

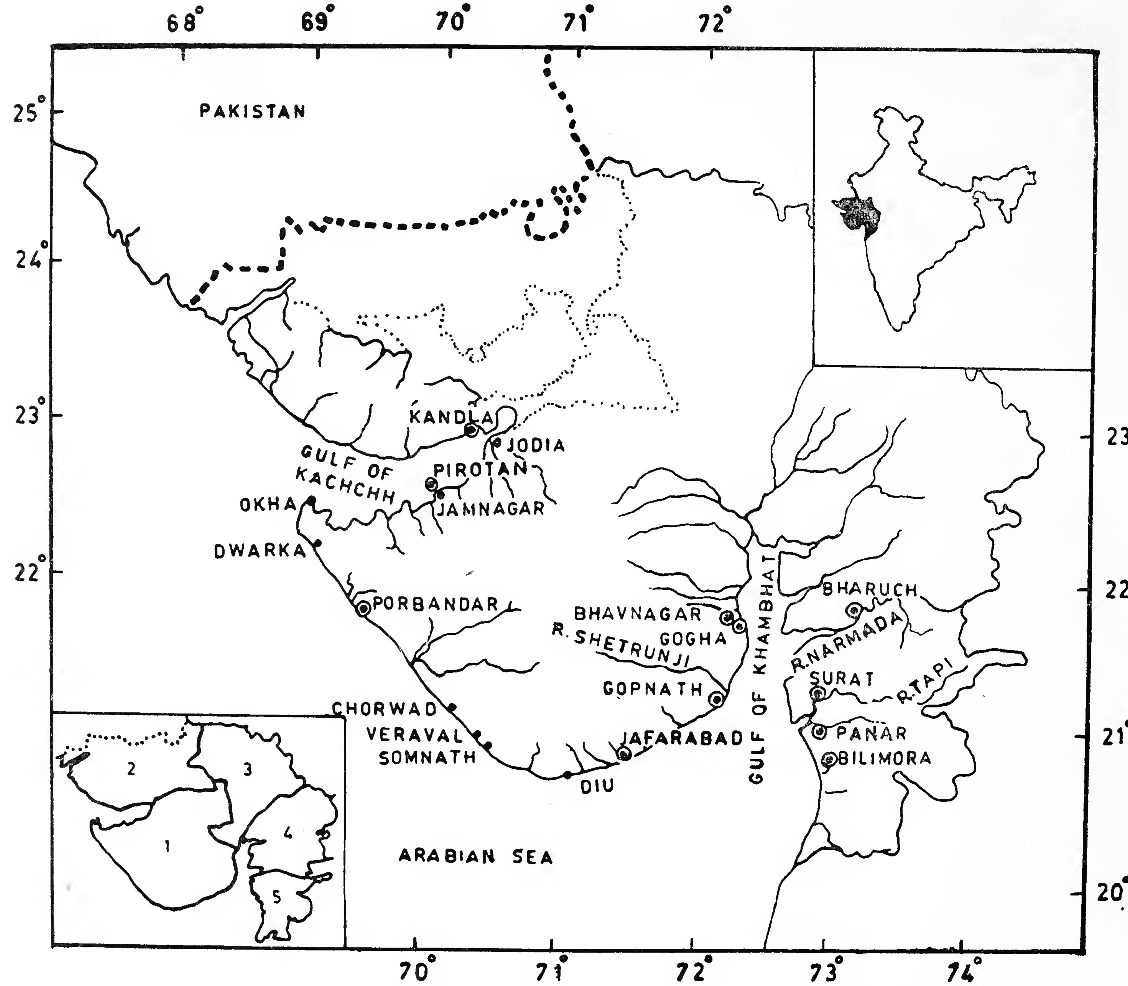


Fig. 1. A map of the Gujarat State locating the places (solid circles) referred to in the text. The locations where the reef herons are found nesting are encircle by open circle. The inset on the upper right shows location of the Gujarat State within India. The inset on the lower left shows a divisions of the Gujarat State into Saurashtra (1), Kuchchh (2) and Gujarat regions, and a further divisions of the Gujarat region into northern (3), Central (4) and southern (5) parts.

a few buildings housing the lighthouse staff and on the southeastern side a small mangrove swamp (Plate 1a). The extensive intertidal zone around the island has silty and/or sandy substratum interspersed on the northern side by reefs of live and dead corals. A large population of the reef heron roosts in and around mangroves on the island along with the Grey Heron (*Ardea cinerea*) and Great White or Large Egret (*A. alba*). During our visit in March, we observed the reef heron as well as the Grey Heron in courtship display, on the mangroves and recorded that a few of them had their facial skin in the nuptial colour

(crimson). We could only reach up to a few nests of the Grey Herons on the periphery of the swamp; it was difficult to move on soft silty floor of the swamp without causing serious disturbance to the birds.

Summarizing the above, the reef herons of Gulf of Kachchh breed on various islands where a natural nesting-habitat is still available and do not seem to do so on the mainland.

Southern coast of Saurashtra

The Saurashtra coast from Okha to Diu (Fig. 1) has a relatively narrow intertidal zone which is mainly sandy and/or rocky. In this sector, we visited Dwarka, Chorwad, Porbandar, Veraval and Somnath and found that the heron on the coast proper is relatively less common in the breeding as well as non-breeding seasons. We have been told that many years ago there was a reef heron colony on mangroves in a riverine estuary of Miyani Creek, near Harsad Mata, north of Porbandar (Lavkumar, Personal Communication). One of us (R.M.N.) visited this place on 7 April 1984, and found that only a few patches of mangroves had managed to survive in the creek and they supported a small colony of the Large Egrets and reef herons. We did not find any heronry in Chorwad, Veraval and Somnath. We, however, found it in Porbandar city, a part of which has grown around the tidal estuaries and creeks.

One, or both, of us visited Porbandar on 18 March 1981 and 3 July 1982. The herons nested here in thickly populated parts of the city and most of the nesting trees were within a kilometer of the feeding places which were the mudflats and tidal pools in the creeks and estuaries (Plate 1b). The nesting trees, chiefly Neem (*Azadirachta indica*), Peepal (*Ficus religiosa*), Banyan (*Ficus benghalensis*) and Casuarina (*Casuarina equisetifolia*), were in the compounds of Rupadiba Hospital (Plate 1c), General Hospital, Court House and Darbar Gadh (Palace) as well as on the sides of Mahatma Gandhi Road. We saw the herons nesting exclusively in March and with the Cattle Egrets (*Bubulcus ibis*), White Ibis (*Threskiornis aethiopica*) and Black Ibis (*Pseudibis papillosa*) in July; this is attributed to the fact, earlier recorded by Naik *et al.* (1981), that the reef heron starts nesting earlier than the other Ciconiiform birds.

From Diu to the Gopnath point (Fig. 1), there are low overhanging cliffs on the coast and the shore is rocky, sandy and muddy. On this stretch of coast the reef heron occurs, but, it is rather sparse. Here, the herons were found nesting in the Jafarabad city in 1982 by Mr. P. C. Malli (Personal Communication). The birds have been nesting in the city for a long time, as they were also observed nesting there about 35 years ago by Mr. B. B. Vaidya (Personal Communication).

In Summary, on the southern coast of Saurashtra which has a shoreline without many bays or creeks and a narrow rocky and/or sandy intertidal zone, the reef heron is sparse or rare. However, wherever there are tidal creeks and estuaries with extensive mudflats, the reef heron occurs commonly and may breed in the nearby cities, exception being a small number of the reef herons nesting on mangroves in the Miyani Creek.

Gulf of Khambhat

Coastline of the gulf of Khambhat (Cambay) extends from Gopnath in Saurashtra to the mouth of Tapi (Tapti) river in south Gujarat. Several rivers from the eastern Saurashtra and central and south Gujarat, including two major rivers Narmada and Tapi, open in the gulf. The silt brought by these rivers has made the gulf rather shallow and muddy. The gulf coast has a gentle slope so that an extensive intertidal zone, which is mainly muddy, is

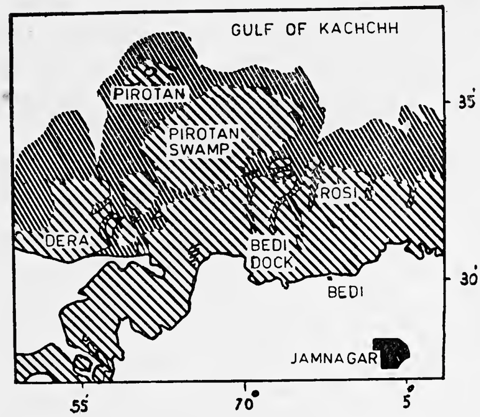
exposed during the low tide (Figs. 3 to 5). Here as in Gulf of Kachch the reef heron is a common bird. For a study of the bird's nesting distribution, we surveyed a small area immediately north of the Gopnath point, Bhavnagar-Gogha area, Bharuch (Broach) city and the banks of Tapi river from Surat to the sea coast.

Both, or one, of us visited the Gopnath area on 8 February and 19 March of 1980, 26 March and 15 May of 1981 and 26 March of 1983, and found four nesting colonies, one each at Gopnath, Gadhula, Khandhera and Pithalpur (Fig. 3).

In a grove of Banyan and Peeper (*Ficus amplissima*) close to a 15th century Gopnath (Shiva) temple, some reef heron pairs were nesting. Two kilometres north of the temple there is Gadhula village (population of 2000 people, who are mainly farm labourers and fishermen) right on the sea coast. The reef herons were nesting in a grove of tall Peepuls and Banyans around a temple of Goddess Kali within the village (Plate 2f). We also saw a Black Ibis and Indian Whitebacked Vulture (*Gyps bengalensis*) pair nesting and a number of Night Herons (*Nycticorax nycticorax*) roosting in the same grove of trees. Plate 2 sharply contrasts a thick growth of trees of the sacred grove (f) with those in the rest of the village (d & e); the trees outside the sacred grove are widely scattered and many of their branches are lopped off.

The other two colonies in the Gopnath area were in the croplands close to the Khandhera and Pithalpur villages. The Khandhera colony of about 30 nests on a Peeper tree is close to a tidal creek, about 2 km away from the coast and about 11 km north of Gopnath. The Pithalpur colony also located in an agricultural farm (Plate 3, g & f) was the biggest colony in this area. The farm, where the colony was located, comprised of a farm house, couple of barns and a cropfield and had about 250 coconut trees (*Cocos nucifera*) planted on its border. The crown of 50 to 60 among the tallest coconut trees here were used by 112 to 133 pairs of herons in different years. There were some young Peeper and Banyan trees on the farm, but these were not used by the herons for nesting. The farmer told us that they first nested in the farm in 1978, and since then they have been nesting every year. During one of our visits in winter we found that many reef herons were roosting on the same coconut trees. Because of the birds' nesting and roosting activities, there was considerable loss of flowers and young coconuts. The coconuts were also damaged by the birds' excreta dropping on them; we saw that the birds' excreta had dripped down the surface of most of the coconut fruits (Plate 3h). The farm owner estimated that he lost about 50% of his coconut crop every year because of the herons. Despite the heavy loss of income, the farmer and his family tolerated the herons and did not molest them in any way. The herons and their broods on top of the tall coconut trees, were almost free from predation. The Cattle Egrets, White Ibis, House Crow (*Corvus splendens*), Jungle Crow (*C. macrorhynchos*), Common Myna (*Acridotheres tristis*) and Rosy Pastor (*Sturnus roseus*) came to roost in the farm, and the Cattle Egrets even nested there. The nesting reef herons readily came down on the ground to collect nesting materials close to the barns and farm house. However, they did not feed on the farm, or anywhere nearby, but flew about 5 km to the sea coast to feed.

In the Gogha-Bhavnagar area (Fig. 4) we found three heron colonies, one each at the Gogha town, New Port of Bhavnagar and Bhavnagar city, within a distance of about



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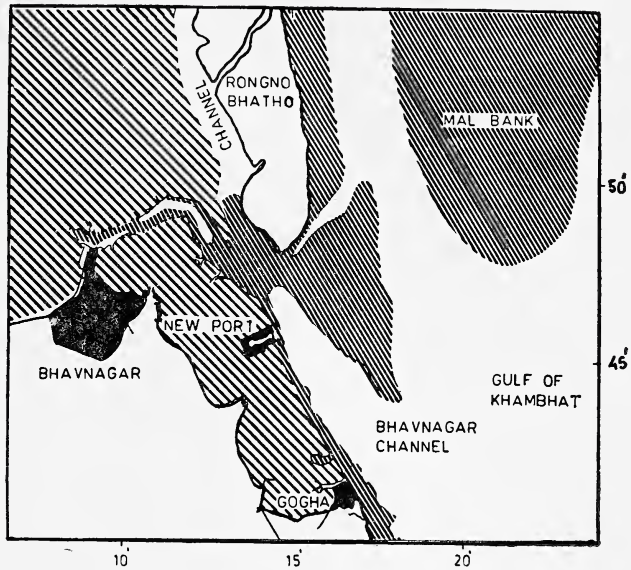

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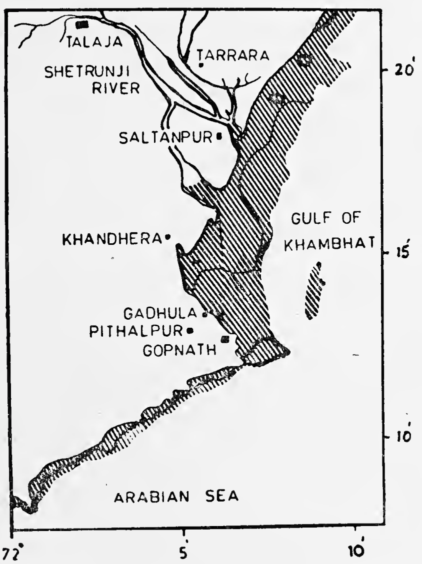

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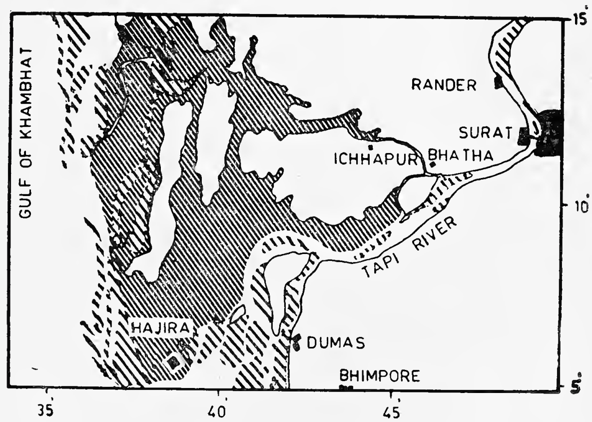


Fig. 5.

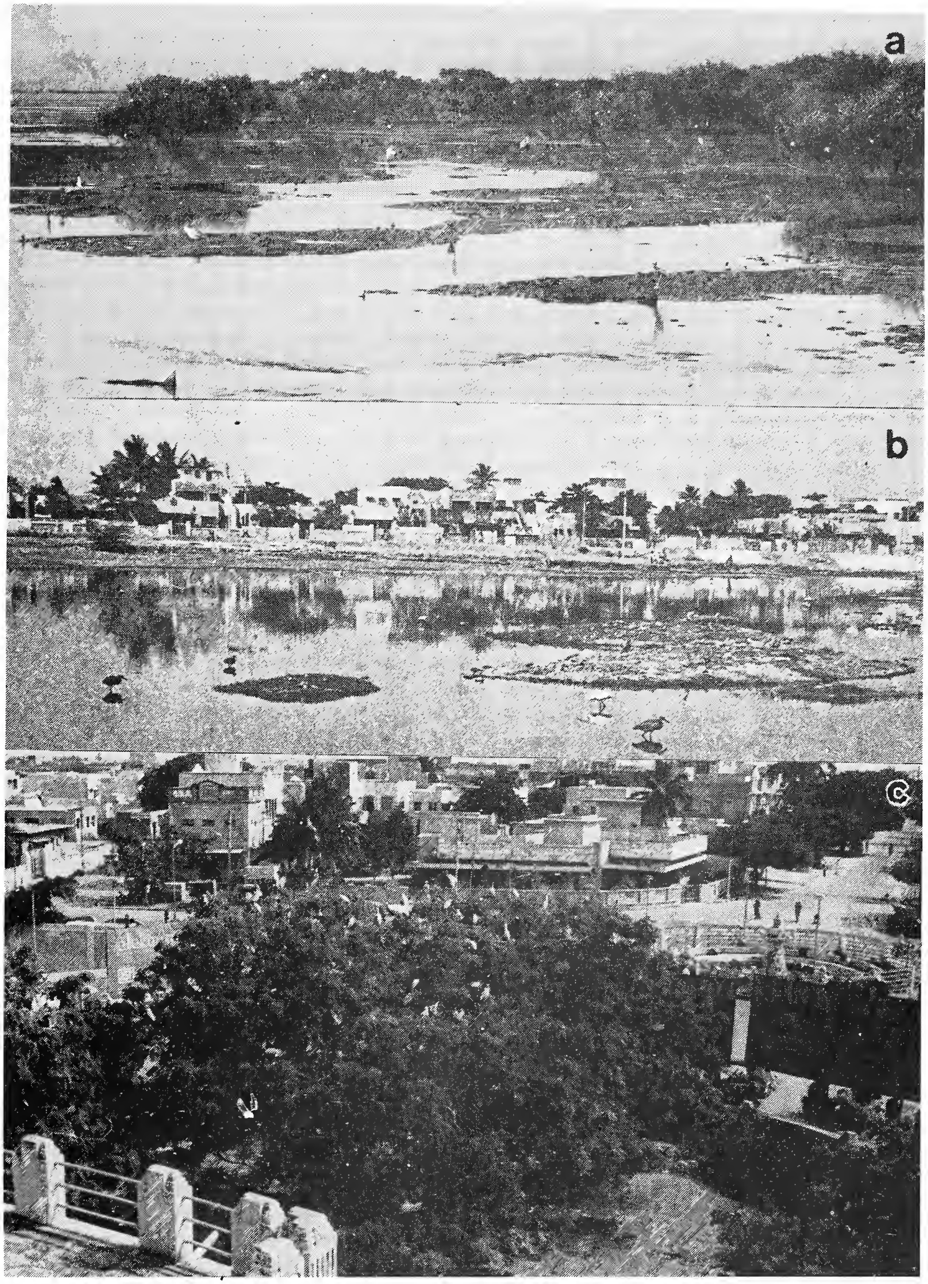
Figs. 2 to 5. Maps showing the extent of intertidal zone near some of the heronry sites, namely, Pirotan island (Fig. 2), Gopnath, Gadhula, Khandhera and Pithalpur (Fig. 3), Gogha, New Port and Bhavnagar (Fig. 4), and Surat and Bhimpore (Fig. 5). The intertidal zone is marked with thin closely spaced lines and the areas partially covered only during the spring tide is hatched with thick widely spaced lines. The rural and urban areas are shown in solid black.

20 km. Because we had selected these areas for the intensive studies of the reef heron to be published elsewhere, we visited them frequently in all seasons throughout the study period.

The Gogha colony is located in a coastal

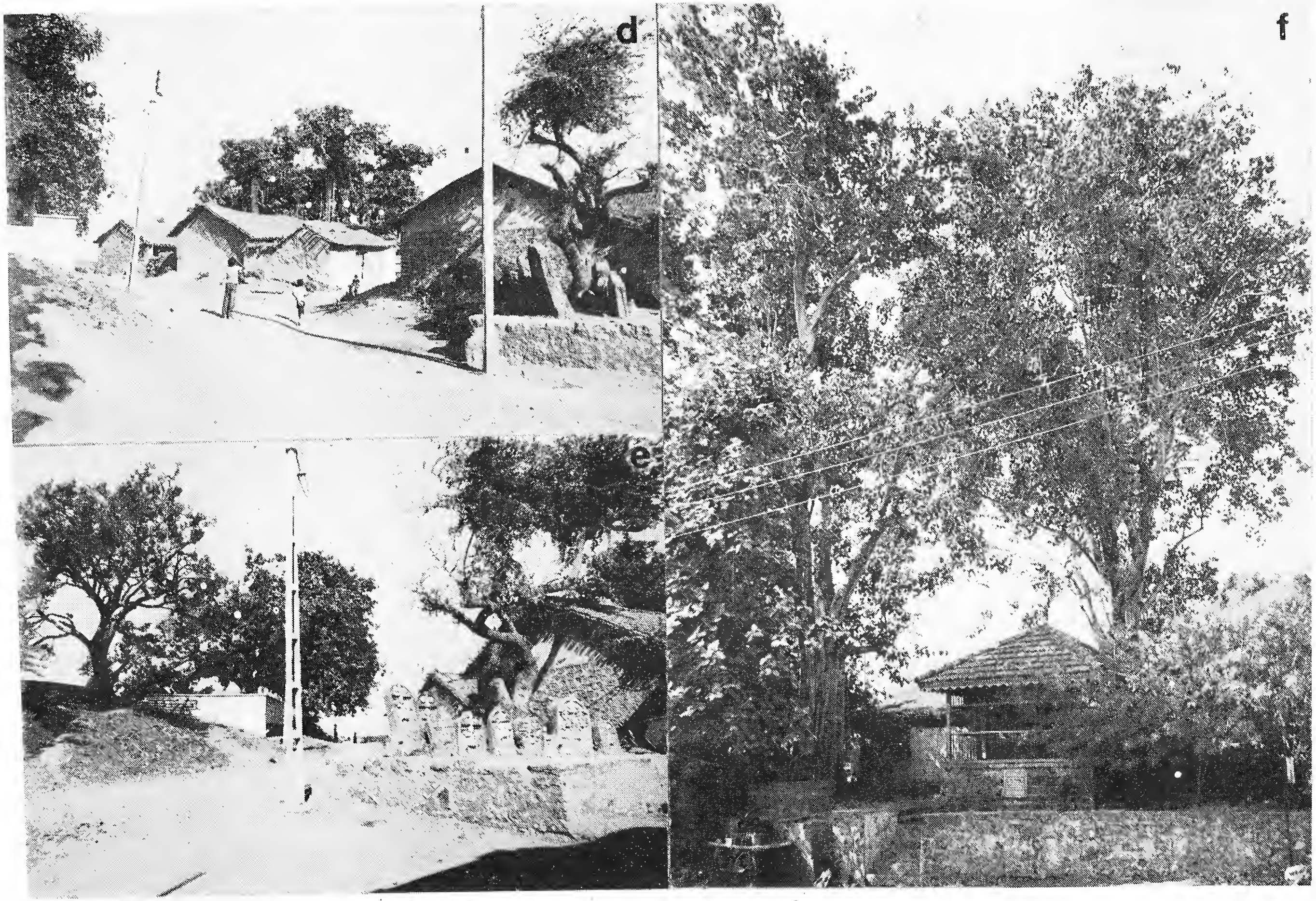
town of Gogha with a population of about 7000 people, a majority of them belonging to fishing and seafaring communities. The colony had been described earlier by Naik *et al.* (1981). The majority of herons here nest in a grove of young Neem, Peeper and Peepul (Plate 4 j & k) within a quadrangle surrounded by the barrack-type buildings housing the Mamlatdar's office, small jail and residential quarters of the constabulary. The Pond Heron (*Ardeola grayii*), Night Heron, Spoonbill (*Platalea leucorodia*) and Painted Stork (*Mycteria leucocephala*) also nested with the reef herons on an old tamarind tree (Plate 4 i) growing at the edge of the premises. Some of the herons also nested on a few huge Tamarind (*Tamarindus indica*) and Peepul growing on the roadside within the town. The birds nesting within the quadrangle of the Mamlatdar's office premises were largely protected against human interference, but those nesting in the town often lost their eggs and chicks because of the predation and interference by the town boys. The nesting trees were used by the reef herons for roosting throughout the year. Within less than half a kilometre flying distance from the colony, the extensive mudflats on the sea shore exposed during the low tides and the tidal creeks, were the feeding grounds of the herons. During the high tides, the herons often visited the nearby fresh water ponds to feed and rest.

The New Port colony where we found the biggest concentration of the nesting reef herons, is located in the port area which is fenced around and human entry to it is severely restricted. The area includes docks, warehouses, administrative and office buildings (but, no residential quarters). The birds nested on Peepul, Peeper, Tamarind, Casuarina, Mesquites (*Prosopis juliflora*) and Portia trees (*Thespesia populnea*) growing on the roadsides close to administrative and office buildings and warehouses, (Plate 5 l & m), within an area of about half a square kilometre. Out of the 70 to 80 nesting trees, a majority were the Portia trees which were short and stunted; none of them being more than 6 m high. A few heron pairs also nested on mangroves (*Avicennia* sp.) close to the seaward side of the port. Though most of the heron's nests were low and the port area was buzzing with activities during certain hours, the herons remained apparently undisturbed, so that they were relatively easy to watch and photograph (Plate 6 n & o). The birds would readily come down from the nesting tree to the ground to pick up nest material. They were actively protected by the dock workers and no one would dare to molest them. The dock workers had even nursed a large number of herons that were stunned by shock and cold during the cyclone which hit Saurashtra in November 1982. Occasional predation of the heron's eggs and chicks by the domestic cat and the House Crow occurred; a few House Crow pairs even nested in the port area from May to July. Among the Pond Heron and White Ibis which nested with the reef heron, the White Ibis was a serious competitor of the heron for the nesting sites. The ibis came into breeding condition later than the herons and occupied the heron nests after ejecting the nest contents. The ibis, however, preferred to nest on top of the tall trees, so that the heron nests built lower in the same trees, and also those on short trees, were not affected. Another reason for the success of the New Port colony is that the nesting birds had rich and extensive feeding grounds available close to the colony. During the low tide, the mudflats except the channel dredged for an approach of ships to dock, became exposed almost up to the horizon, and birds avidly fed on the mudskippers and other fishes from the mudflats and tidal pools. When the coast was covered with water, the herons often visit-



Feeding and nesting sites of the reef heron. (a) A part of the Pirotan island and adjoining intertidal zone. (b) A tidal creek near Chhaya plot, Porbandar. (c) A nesting tree of the cattle egret and reef heron in a hospital compound, Porbandar.

(*Photos:* Author)



(d & e) General views of the Gadhula village. (f) Nesting trees of the reef herons in a sacred grove in Gadhula.

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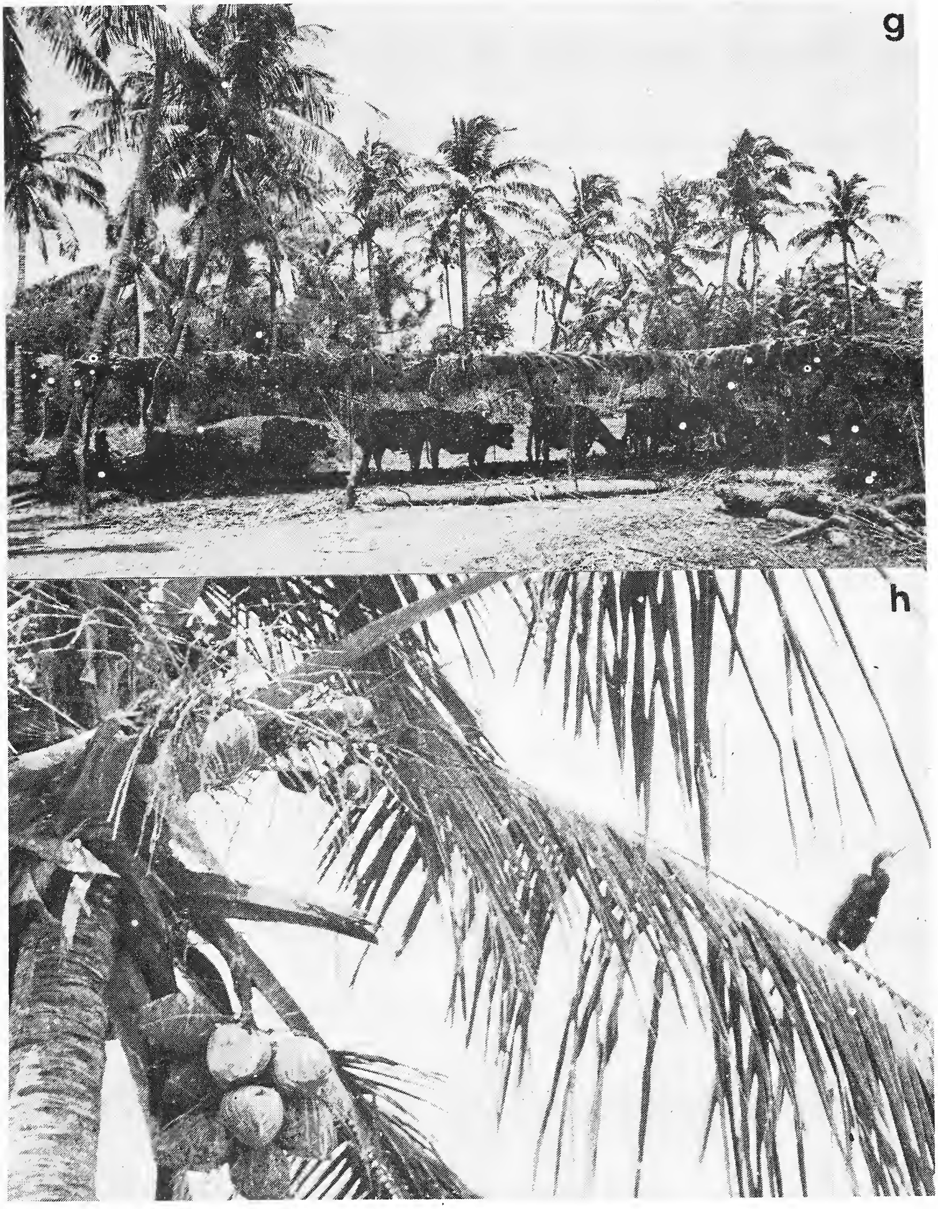

(g) Nesting trees of the reef heron in a Pithalpur farm. (h) A close-up view of the Coconut fruits smeared with the herons' droppings.

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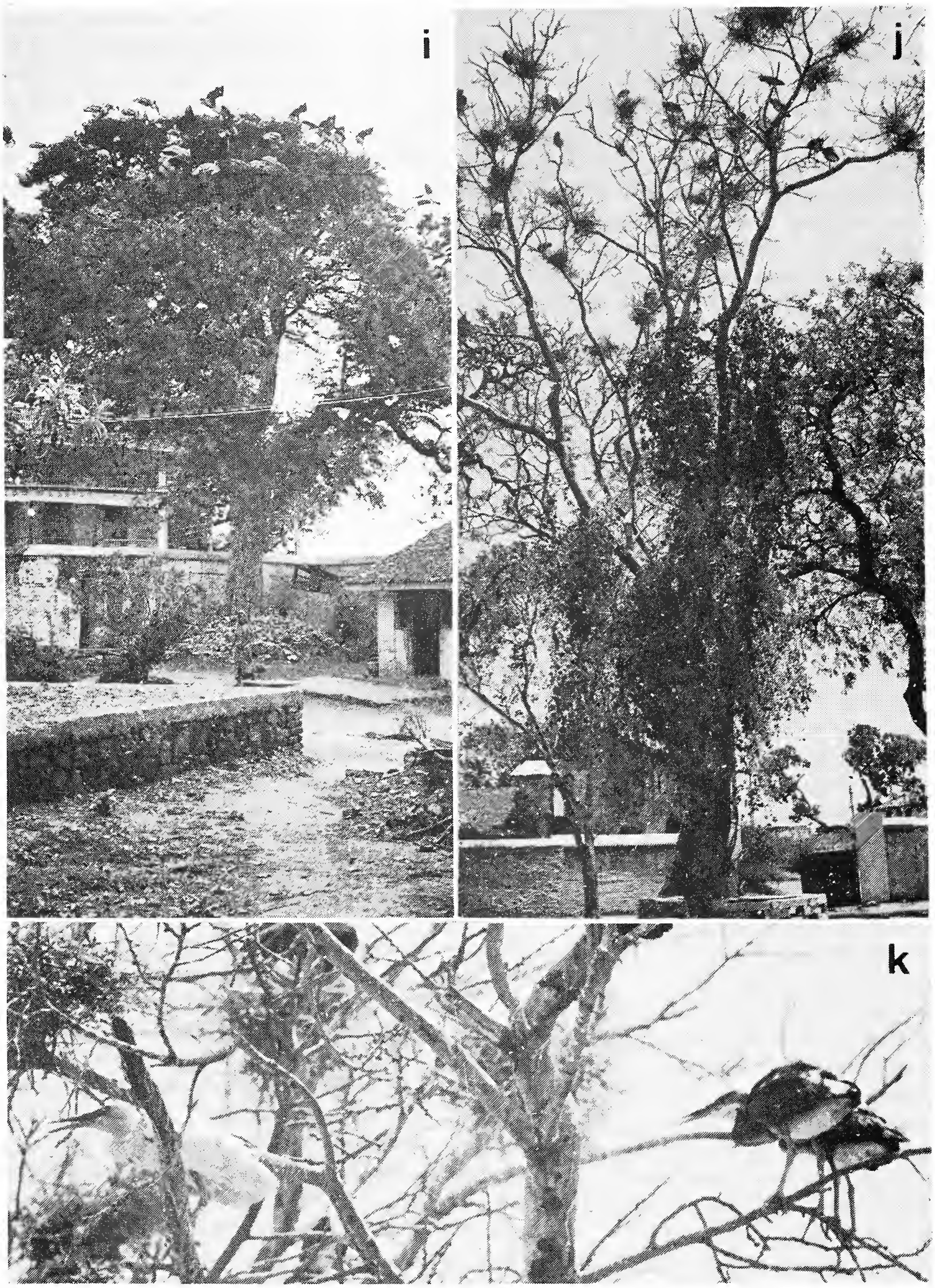
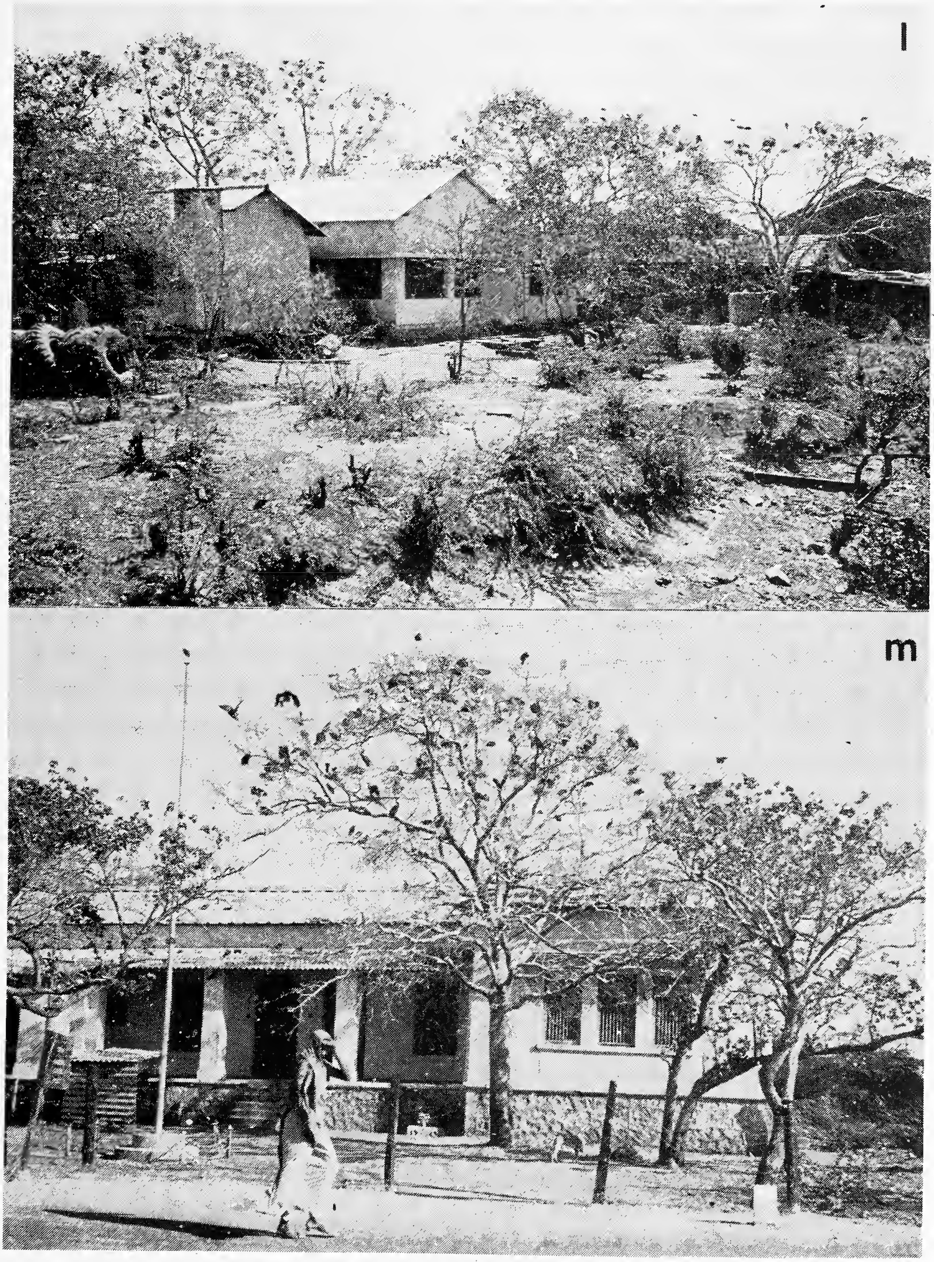


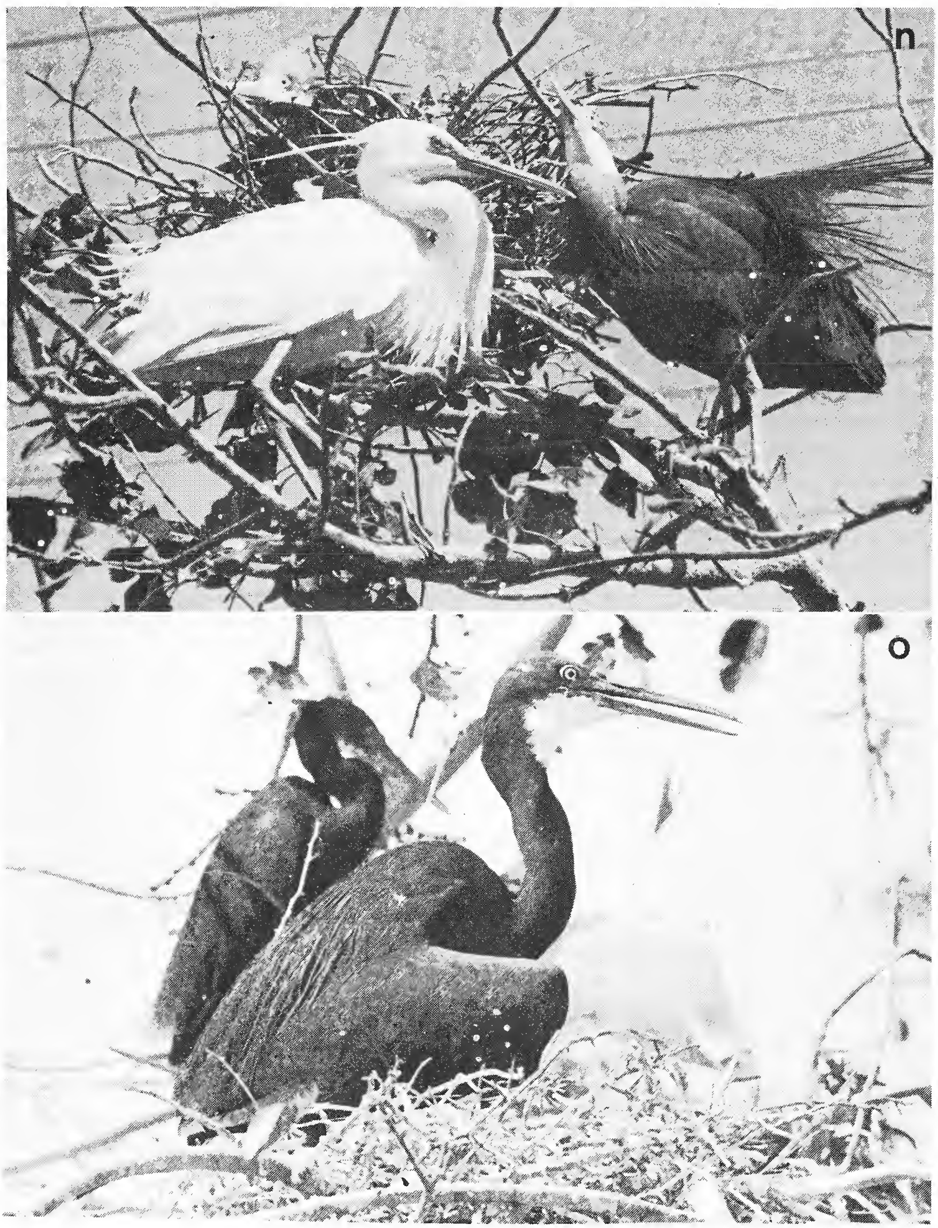
The Gogha heronry in the Mamlatdar Office compound. (i) A Tamarind tree used for nesting by the painted stork and reef heron. (j) A Peepul with the reef heron nests. (k) Two grey phase nestlings (right) and a white phase adult (left) on a nesting tree.

(*Photos:* Author)



(l & m) Two views of the New Port heronry.

(*Photos:* Author)



The reef herons in the New Port heronry. (n) A grey-white pair in courtship display. (o) A grey phase heron shading its young in the nest.

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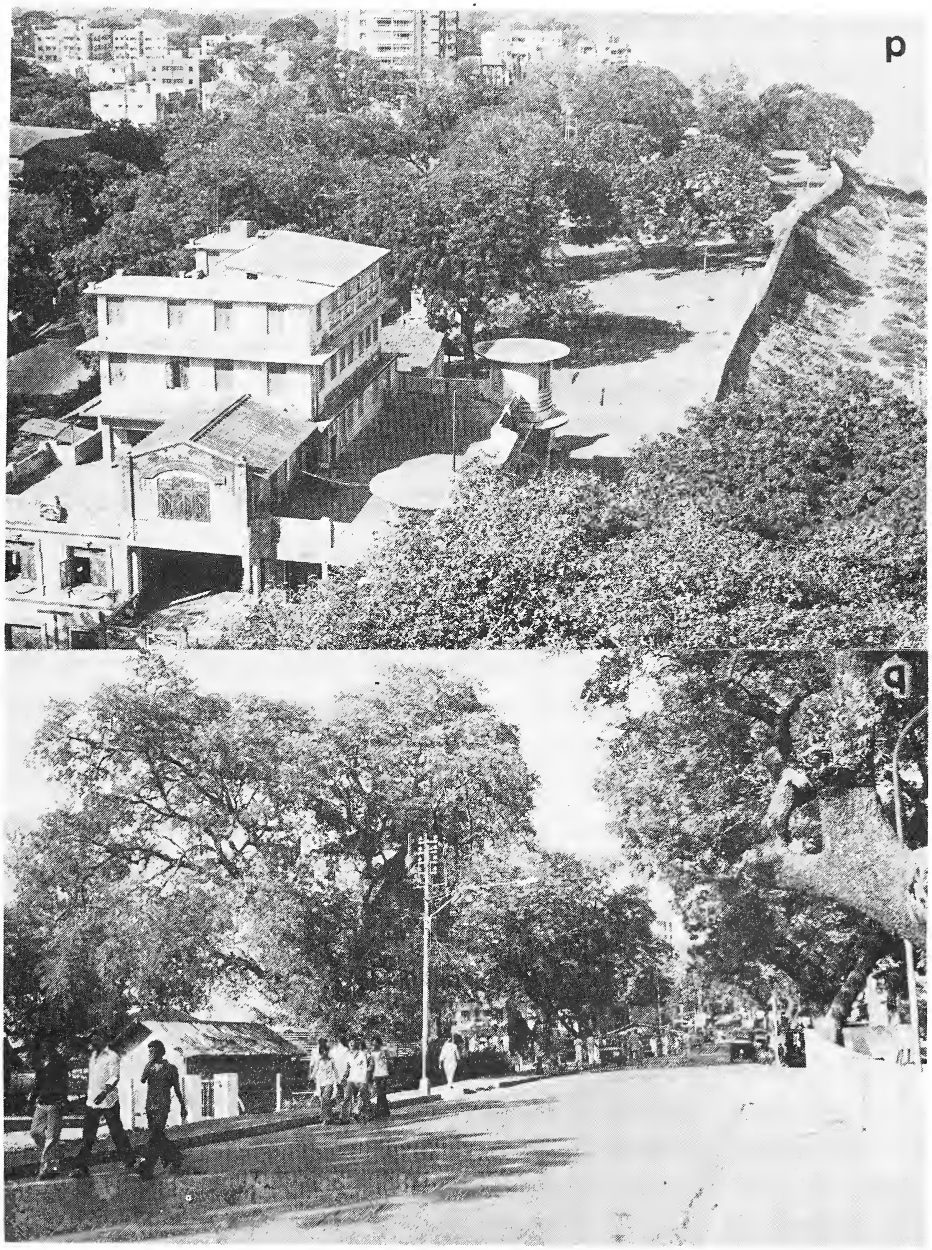

The Surat heronry. (p) An aerial view. (q) A view from the street level.

(*Photos:* Author)

ed the salt pans to feed.

The Bhavnagar colony is located in an urban setting. The reef heron breeds here chiefly on Peepul in the thickly populated Old City area, though some pairs also nested on a wide variety of trees in a public garden and the suburban areas. The other colonial nesters nesting in the colony were the Indian Pond Heron, Cattle Egret, Large Egret, Night Heron, Painted Stork, White Ibis and Spoonbill. The herons of this colony fed on the mudflats and tidal pools in estuary and tidal creeks, salt pans and fresh water reservoirs near the city, and the citizens did not permit deliberate molestation of the nesting birds. A more detailed and illustrated account of the Bhavnagar colony is given by Parasharya and Naik (1983).

One of us (R.M.N.) visited the Bharuch colony on the western coast of Gulf of Khambhat only once in April 1983. The nesting had just started and there were about 20 nests on the roadside Neem and Peepul, close to a large fresh water reservoir, within an old and thickly populated part of the city. The birds fed on the tidal estuaries of the Narmada river and also on the banks of freshwater reservoir. A few pairs of Large Egret were also nesting with the reef herons.

One, or both, of us visited Surat and its vicinity several times. We found one colony in Surat. We also surveyed both the banks of Tapi river downstream from Surat to the sea coast (Fig. 5), and found only one more colony at Bhimpore, east of the point where the river meets the sea.

The Surat colony is located in Nanpura, a suburban locality on the eastern bank of the Tapi river (Plate 7 p & q). There are several large old nesting trees in the compound of Judges' colony, on the roadsides around the District Court building, in the compounds of several bungalows and in the Dutch garden which is open to the public. The nesting trees were mainly Neem, Peepul and Casuarina but a few of them were on Coconut trees and a Date palm (*Phoenix dactylifera*). The birds fed on the mudskippers from the muddy banks of the river exposed during the low tide. The birds often fed close to the nesting colony, but they also foraged in the tidal estuaries farther from the colony. The Large Egrets, Night Herons and Cattle Egrets nested with the reef heron. The birds were not usually molested by the people, though occasionally those living in the nearby hutments killed the birds.

Bhimpore (Fig. 5), where the other heron colony in the Surat area is located, is a small coastal village inhabited by fishermen and sailors. Boys from this village had no compunction in killing the herons or other birds for food. Correlated with this, there was only one tree with a few reef heron nests, standing beside a road right in the village. This was despite the fact that there were extensive mudflats exposed during low tide close to the village, and we saw a large number of reef herons and Large Egrets feeding there.

Summarizing the status of reef herons of the Gulf of Khambhat, there are extensive feeding habitats available, but, there is an overall scarcity of safe habitats for nesting away from the human settlements. In the coastal villages and towns, the safe nesting trees are relatively few, so that the birds tend to move to the coastal cities, or alternatively to the cities or croplands further inland, for nesting.

The rest of south Gujarat

We have personally not surveyed any area south of Surat. However, there are reliable records of the reef heron nesting in small numbers in Panar village (R. M. Desai, Personal Communication) and Billimora City (Raju Vyas, Personal Communication). Apparently, the reef herons in the rest of south

Gujarat, as those in the Surat area, turn inland to nest in villages, towns and cities on the river banks.

Discussion

The preferred habitats of the Indian Reef Heron on the coast of Gujarat State are the tidal mudflats, mangrove swamps, estuaries and tidal creeks. Freshwater reservoirs are also frequented, but, the birds are very scarce on pure rocky, sandy or sandy-rocky shore. The reef heron on a sea shore with golden sand and a rocky outcrop as picturized in a painting by R. Gillmor in the book by Hancock and Elliot (1978) is certainly a very rare sight in Saurashtra, Gujarat. In the shallow waters of the Gulf of Kachchh, we have seen the reef heron feeding on the reef but it was outnumbered by the Large Egret and Grey Heron; the reef herons were most numerous wherever the shore had muddy and sandy-muddy substratum.

Our investigations on the food and feeding habits of the reef heron in Gulf of Khambhat have revealed that the adult and nestling food was mainly mudskippers picked up from the mudflats, and also small fishes and shrimps picked up from the shallow waters during flood or ebb-tide and from the tidal pools (Parasharya and Naik, unpublished).

The proximity of preferred feeding habitat is a chief requirement for the location of a bird's breeding colony. The reef heron's preferred habitats are extensive in Gulfs of Khambhat and Kachchh. Gulf of Kachchh receives a large quantity of silt with the monsoon floods in numerous desert rivers opening into it and also by the coastal erosion; the silty beds of mangrove swamps, creeks and bays create the type of feeding habitat preferred by the heron. Gulf of Khambhat has its coastline dotted with extensive estuaries which provide ample food to the herons. The southern shore of Saurashtra is rocky and sandy and not preferred by the herons. However, wherever the rivers and creeks open on this stretch of Saurashtra coast to create estuaries and bays, such as, near Harshad Mata, Porbandar and Jafarabad, the heron's preferred feeding habitat is most likely to occur. Similarly, mouths of several small but perennial rivers on the Gujarat coast south of Gulf of Khambhat provide suitable feeding habitat pockets.

In all the places with suitable habitat described above, the reef herons occur, but, whether they breed anywhere near there, depends on the availability of safe nesting sites. An extensive growth of mangroves which occurred at one time almost all along the coastal regions, provided ample safe nesting sites for the coastal birds. Such conditions exist today only in the Gulf of Kachchh, whereas at other places the mangrove forests have been completely cut down or degraded. In Saurashtra and Kachchh which are largely arid and semi-arid, there is a general scarcity of trees and it is acute particularly along the coastal belt, where large trees exist only in villages, towns and cities.

The heron's traditional nesting sites in the mangroves, being still available, continue to be used in Gulf of Kachchh, and the birds do not seem to associate with the human settlements for nesting on the gulf coast. Elsewhere, the herons have taken to nesting in cities, towns and villages. Here, the nesting of herons is intimately linked with the regional differences in the cultural environment of human settlements. In the small coastal settlements, such as in villages and small towns, the fishing and seafaring communities are dominant and animal food predominates in their diet. In such a settlement, whereas the adults go for fishing the children roam around the village and countryside snaring birds and other animals

to supplement the family larder; the colonial nesting of birds, being conspicuous, would rarely succeed here. The situation is illustrated in the case study of the Bhimpore colony. Though the rich and extensive feeding grounds near Bhimpore were being exploited by the herons in large numbers, very few of them attempted nesting in the village because it was unsafe to do so. Even in such settlements, occasionally a refuge for the nesting birds may come about under certain conditions; the examples in our case studies were the Gadhula, Gopnath and Gogha colonies. In the Gadhula village, the nesting colony in a grove of old trees had some degree of protection from active human interference by virtue of its proximity to a temple. The Gopnath colony also derived similar protection. Killing or molesting animals other than the sacrificial ones, near a place of worship is a taboo observed by most of the communities. In the Gogha town, the nesting herons derive protection in a slightly different way, from their proximity to a seat of authority; the core area of the colony was within the quadrangle of Mamlatdar's office patrolled day and night by armed guards, whose mere sight was a deterrent to the town boys intending to appropriate eggs and chicks from the colony.

The Gadhula-Gogha type protection to nesting birds is limited only to a small number of trees per place and does not happen at many villages in coastal areas, so that the birds turn to a large city if there is any around. A city, whether coastal or inland, has many localities which offer safe nesting sites to tree-nesting colonial birds; the only serious limiting factor for the urban nesting seems to be scarcity of the nest-building materials. The heron colonies at Porbandar, Jafarabad and Bhavnagar were relatively safe from human interference and at the same time close to the feeding areas. In absence of suitable safe nesting sites on the coast, the birds of the Surat colony (and probably also of the Bharuch colony) had selected a city on a large river but away from the coast; the birds did not get all their food close to the colony and had to go long distance for foraging, but it was a compromise for securing safe nesting sites.

Compromising the foraging distance for a safe nesting site was nowhere more apparent than at the Pithalpur colony (and probably also at the Khandhera colony) located inland in croplands. Unlike the coastal fishing communities, most of the inland farming and pastoral communities in our study area are strict vegetarian in their dietary habits and abhor killing of and cruelty to animals. Their compassion for animals is sometime stretched to such an extent as to include animals that would be labelled as 'pests'. The herons nesting or roosting on the coconut trees on a farm near Pithalpur, were positively destructive to the coconut crop and it would have been possible to scare them off the farm, but the farmer did not do so.

The New Port colony had the most ideal setting among the colonies observed by us on the dryland. A factor limiting the number of birds nesting there was the number of nesting trees. Our case study of this colony had clearly illustrated that a human work-area could give a better protection to the nesting birds than a residential area.

The reef heron feeds in suitable habitats all along the coast when it is not breeding. At this time, it roosts communally on the safe sites close to the feeding grounds. These roosts are essentially transitory and may be changed from time to time, though some of them may be used also for nesting. As in most Ciconiiform birds, the suitable nesting sites of the reef heron are far less than the suitable night roosts, so that the birds are forced to move

locally in search of the nesting colonies for breeding.

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MATING BEHAVIOUR AND MATE CHOICE BY WILD AXIS DEER IN SRI LANKA[1]

CYRILLE BARRETTE[2]

(*With five plates*)

During 20 months of field work in Wilpattu National Park (8°30'N, 80°1'E) in Sri Lanka I observed 24 complete sequences of mating in Axis deer (*Cervus axis*). I present here a description of 11 behavior patterns that constitute the sexual repertoire of the species. This I think will assist observers interested in all aspects of mating success and sexual selection in that polygynous species. I particularly make a distinction between mounting and inseminating, the latter being evident from the conspicuous thrust performed by the male. I also extend and confirm what others have shown, namely that most copulations (23 out of 24 in this study, and 61 out of 68, 90%, overall) are performed by the males in the largest antler-size class (about 75 cm or longer), even though they represent only some 30% of the adult males. Finally, I present some observations that strongly suggest that females can show an active preference for some males as mating partners.

INTRODUCTION

Among the repertoire of social behaviors of a species, mating behavior, i.e. courtship and copulation, is seldom fully and accurately described. This is certainly the case for wild mammals. In his excellent review of the subject, Dewsbury (1972) did stress the lack of extensive information on courtship and copulation of wild mammals in nature. Although the situation has improved since the publication of his seminal paper, only a few mammals, apart from primates, are adequately known (e.g. among wild ungulates: Geist 1971, 1981; Struhsaker 1967, Buechner & Schloeth 1965, Bützler 1974, Kurt 1968, Dubost 1971, Dubost & Feer 1981, Wemmer *et al.* 1983, Bergerud 1974, Bromley & Kitchen 1974, Lent 1974, Leuthold 1977, Walther 1984, Moss 1983).

Because they are rather stereotyped, courtship and copulatory behaviors are at once indicative of phylogeny (see Brown 1975), are very important for the reproductive isolation of species (an important theme in Mayr 1963) and may play an important role in female mate choice (see Bateson 1983). In addition, for the naturalist working under difficult field conditions, it may be of great use to know the full repertoire of courtship and mating. One can then infer with confidence from the incomplete observations often imposed by viewing distances or by forest habitats for instance, whether animals have actually mated. In the same way, once one knows the full sequence of events leading to copulation one can predict whether a courting pair that happens to get out of sight before copulation, will mate in that particular instance of courtship. In the case of forest animals this is particularly important. For instance, Markgren (1969), an authority on Moose (*Alces alces*) has written: "Successful mountings and completed coitus have rarely been observed. I have not seen one myself in seven years of field studies. This is unfortunate as this would be one way to determine the oestrus time of the cows ..."

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(Markgren 1969: 160) It is the main purpose of this paper to provide such necessary information on the Axis deer, or Chital (*Cervus axis*) living under natural conditions. Although Axis are locally numerous, and gregarious, thus relatively easy to observe, their mating behavior has only seldom been observed in their natural habitat, e.g. Schaller (1967) in his 14 month thorough and very inspiring study at Kanha in central India recorded only 2 copulations. In addition to describing the sexual behavior of Axis, I will use that information to discuss the intriguing subject of female mate choice, i.e. do larger males have privileged access to females only because they win in the intermale competition, or are they also preferred by the females as mating partners (see Bateson 1983 for a recent discussion of this important distinction initially made by Darwin 1871).

Study area and Method

I studied Axis in Wilpattu National Park (1300 km^2) in Sri Lanka (8°30′N, 80°1′E) from September 1972 to October 1973, then again from April to October 1983, for a total of 20 months. Axis are numerous in the park, there were a minimum of 1000 of them (actual count on September 8, 1983) in the central part of the park where most observations were made. That study area is a 25 km^2 track of forest, interspersed with 12 rather permanent water holes (*villus*), each in the middle of a clearing whose diameter varies from about 200 m to 1 km (see Eisenberg & Lockhart 1972, for a description of the ecology of Wilpattu).

All observations were made from a vehicle that acted as a very efficient and convenient blind. Axis seemed to ignore the presence of the vehicle and they could thus be observed at close range without disturbance. Binoculars and a 20X telescope were used whenever necessary. The deer could be observed at almost any hour but were most active in the open from sunrise (around 0600) to about 1000, and from 1600 to sunset (around 1830). Observations were dictated to a field assistant who wrote down in coded form the behaviors as they occurred.

Results and Discussion

I have observed 24 full sequences of mating, 16 in 1973 and 8 in 1983. These include only cases where an ejaculatory thrust (see later) was actually seen. Courtship behavior was observed almost daily, in any month, with no obvious seasonal pattern. This is consistent with the fact that in Sri Lanka, Axis fawns can be born in any month (Phillips 1935, Eisenberg & Lockhart 1972, Barrette in prep.). In most instances of courtship, males performed only the first 3 or 4 patterns described here. The frequency of production of sexual behavior patterns by males of various antler-size classes in Wilpattu is very similar to what Schaller (1967) has reported for Kanha in central India. I therefore will not deal with that here. I will only give a description of the 11 patterns (10 illustrated with photographs) that constitute a complete sequence of courtship and mating. Some of them have been described by Schaller (1967) and Fuchs (1977). Many of these patterns are of course common to most Artiodactyls as well, as can be seen in the references cited in the introduction (e.g. Walther 1984).

1. *Low stretch.* This is an unambiguous sexual approach (Plate I, Fig. 1). The male's nose is pointed forward and his neck is held at or near the horizontal. Thus his antlers are laid back; i.e. relatively hidden from the female. The male usually flicks his tongue

rapidly as if licking in vacuo, and his penis is unsheated and pulsating more or less vigorously in the sagittal plane, both up and down, and in and out. The rythmic movement is thus not passively produced by the walking movements of the male. That action of the penis is very common in courting males, and is usually present at the merest approach toward a female, whether in the low stretch posture or not. It is so conspicuous that it may be a visual display. This is very different from the erection seen in violent fights. In the latter situation the penis is rigid and tucked against the animal's abdomen. The usual reaction of the female to a low stretch is to withdraw before being touched by the male, and she usually voids a few drops of urine while withdrawing (see Geist's 1981 discussion of that).

2. *Lipcurl* (*Flehmen*). After the female has withdrawn a few steps the male sniffs and/or licks the urine she left on the ground. Then raising his head in a posture very similar to the low stretch, the male stays motionless, except for an occasional slow and shallow vertical oscillation of the head. His upper lip is curled backward, his nares pinched almost completely, and his eyes partly or fully closed. The male stays in that transe-like posture for some 10 to 20 seconds, his muzzle pulsating as he breathes. He then lowers his head and actively licks his muzzle. Lipcurl apparently allows a male to assess the sexual receptivity of a female by sensing sexual hormones in her urine with the vomeronasal (or Jakobson) organ located above the roof of the mouth and connected to it through the incisive ducts (Dagg & Taub 1970, Estes 1972, Reinhardt 1983). As Geist (1981) has very aptly said, one of the primary purpose of courtship in Ungulates is to obtain urine from the female, in order to evaluate her degree of receptivity. In Chital, females lipcurl very seldom (I have seen it only once), fawns do it on occasion, like they playfully mount each other or adult females; velvet antlered males do it seldom, but hard antlered males lipcurl often. The performance of one lipcurl to the urine of a given female is usually a turning point in the courtship activity of a pair. In the vast majority of cases, lipcurl signals the end of courtship; a male presumably loses interest in a female once he has found out that she is not fully receptive (i.e. near oestrus). After such a lipcurl, a male ignores that given female and either approaches another one or grazes.

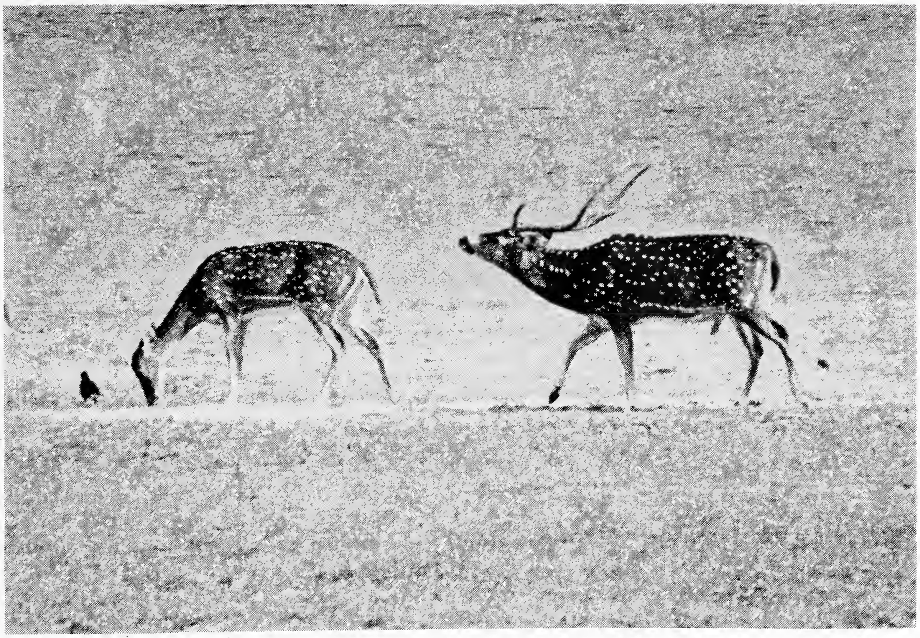
In addition to lipcurls performed during a social interaction, males are often seen to lipcurl by themselves, presumably to urine found on the ground.

3. *Guarding.* This is a very conspicuous behavior (Plate I, Fig. 2). The head is held high, the neck is stiff, the tail is stiff and strongly arched over the back, not merely vertical as in alarm behavior. Also the male marches in a stiff and exagerated manner, lifting his feet high and stamping them forcefully on the ground. The front feet are also occasionally stamped in place, as in alarm behavior. The male's penis is never visible during guarding. The male never grazes during a guarding episode, and never faces the female; he usually stays a few steps ahead of her, either parallel to her (Fig. 2), or blocking her way, he moves when she moves and stops when she stops. Whenever she drips urine, he picks it up and lipcurls, then resumes guarding. The best interpretation I can find for guarding is that the female is very close to oestrus, but not quite ready to be mated. This is supported by the fact that of all the instances of guarding I have seen (around 100), I have seen only twice a male mate with the female he was guarding. Thus guarding clearly indicates an intense interest in a female, but usually

does not immediately precede mating. Guarding is usually performed by the larger hard-antlered males (called big hards, i.e. males with antlers about 75 cm long or more). But guarding is not seen in all instances of courtship or mating, and it does not seem to be only a matter of the female's receptivity (see later in the section on mate choice). A guarding male is usually very persistent, and can guard non-stop for more than an hour. Occasionally however, a male seems to become impatient and will chase the female at a full run over hundreds of metres. Some of the chases are triggered by the female first trotting away from the male, but usually it is the male that does the first move, rushing one or two steps at the female with antlers pointing forward, and stamping both fore feet at once on the ground, the female then rushes off and the male chases her. As soon as she stops, he shops and resumes guarding. I do not agree with Schaller (1967:84) and Fuchs (1977:39) who call this posture a dominance or aggressive display. Although the guarding behavior is reminiscent of the "head-up display" of Schaller (1967:72), it is different in many aspects (the tail, the ears, the high stepping), and I never saw it performed among males. In addition, very often a male will perform his guarding in the absence of any other males, leaving no possibility of interpreting guarding as a form of inter-male aggressive display. Finally, a guarding male does not seem to attempt to herd a female either away from rivals, or back into the herd as some territorial bovids (Walther 1984), or harem forming cervids (Struhsaker 1967, Clutton-Brock *et al.* 1982) do. It seems that all that a male Chital tries to achieve is to advertize his presence and his persistence, by constantly monitoring, following and/or controlling the female's moves. If another male approaches however, a guarding male will occasionally lunge a few steps in his direction to have him withdraw.

4. *Licking vulva.* The first, and the most common, physical contact that a female Chital allows a courting male to do, is vulva licking (Plate II, Fig. 3). The female may move ahead at the instant of contact, or stand for many seconds and urinate (as on Fig. 3) while the male actively licks her vulva and drinks the urine. Either before, or immediately after, the female has moved ahead, the male usually lipcurls.

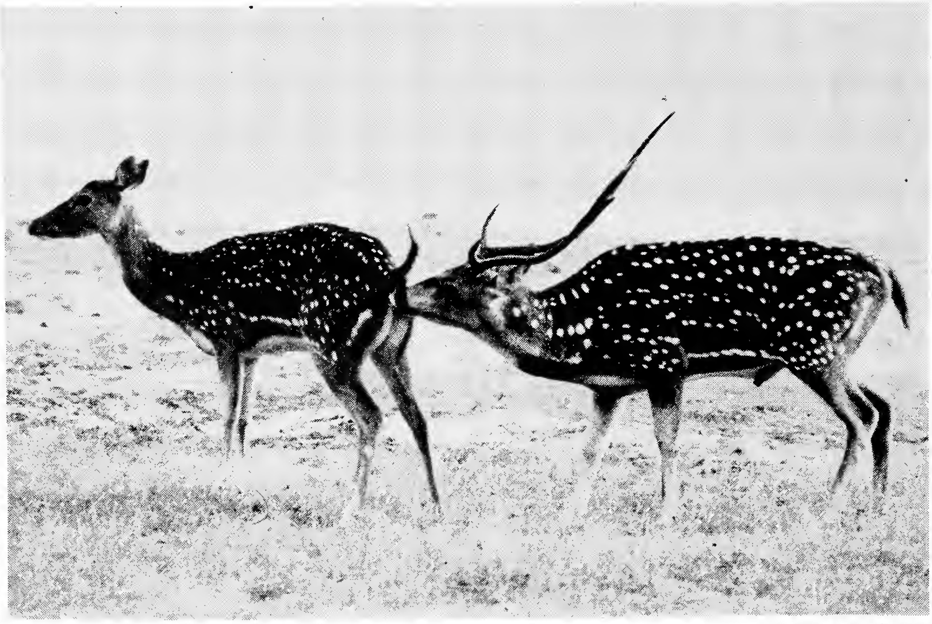
5. *Chin on rump.* If the female does not walk ahead during vulva licking, the male will eventually place his chin on her rump, flicking his tongue all the while, thus licking the female's rump. In the case illustrated (Plate II, Fig. 4), the female is standing, and holding her tail to the side. The male is about to rear (as evidenced by his lifted right fore leg) and mount. Almost all mounts (see later) are preceded by chin on rump, but in most cases, the female responds by moving ahead, with the male trailing her in low stretch, tongue flicking, licking vulva, chin on rump, and so on. This tending can go on for one hour or more before the female allows the male to mount, and in most observations, the animals get out of sight before it happens. When they do stay in sight for a long time, it very often happens that they do not mate at all even after a long tending period, the male eventually giving up, and grazing or resting. Thus chin on rump and the rest of tending are not reliable signs that mating is about to take place. Also, chin on rump is of course not a direct way for a male to restrain a female in order to mount her. It is more like a signal announcing the male's intention to mount. It is the female's response to that signal, i.e. walking or standing, that will result in the male mount-



Above: Fig. 1. Low stretch. Note the difference in the tails, the female is probably dripping urine.

Below: Fig. 2. Guarding. A female that constantly holds her tail like here, has likely been bred not long ago.

(*Photos:* Author)



Above: Fig. 3. Vulva licking. The female's arched back, raised tail and spread hind legs indicate that she is urinating. (Figures 3 to 10 incl. are from a single mating sequence).

Below: Fig. 4. Chin on rump. The female's tail is not wagging but held stiff and sideways.

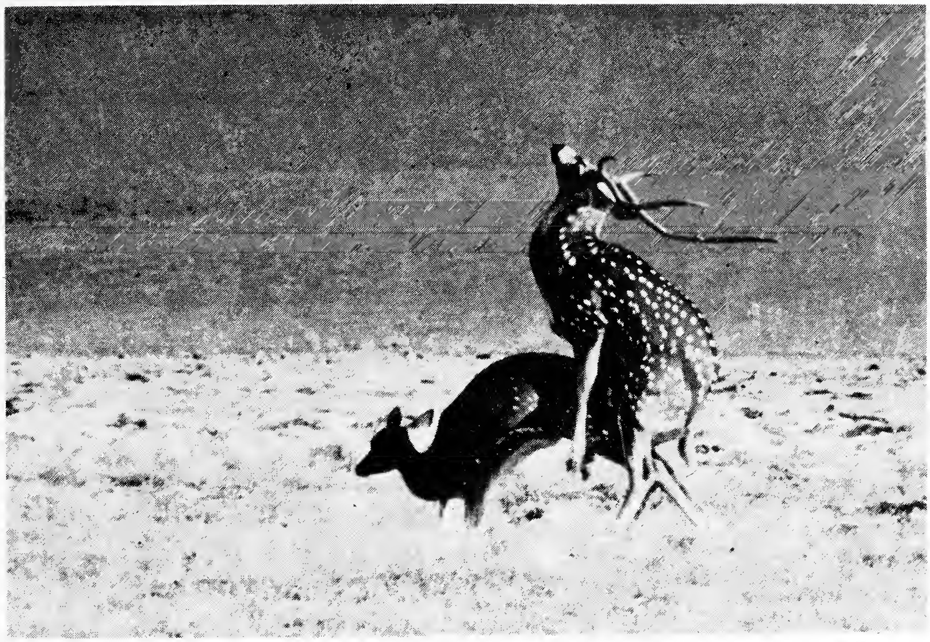
(*Photos:* Author)

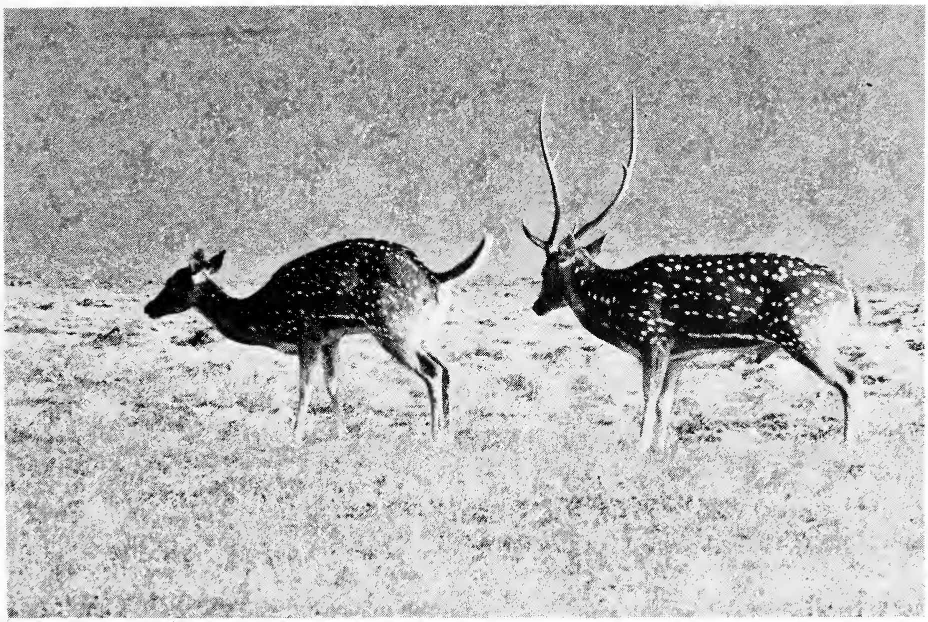
Above: Fig. 5. Chest licking. The male's tongue is visible. See how contorted he must be in order to lick the female's chest.

Below: Fig. 6. Attempted mount. The female is in the process of turning, just prior to stepping forward.

(*Photos:* Author)

Above: Fig. 7. Mount. The male is as far forward on the female as is possible.
Below: Fig. 8. Mount leading to intromission.
(*Photos:* Author)





Above: Fig. 9. Ejaculatory thrust. Note that the male's hind feet have moved adhead of the femal's, as compared to Figure 7. The female has fallen on her wrist joints. (This is taken from a colour slide).

Below: Fig. 10. Post copulatory postures.

(*Photos:* Author)

ing or not. Even though chin on rump cannot physically restrain the female, it may however function in a reflex manner as in suids, inducing a female to stop and stand firm (Signoret *et al.* 1975).

6. *Licking of the chest.* Chest licking is, as far as I could see, as sure a sign as any that mating is imminent. In this behavior, the male is beside the female and, twisting his head, he licks the ventral side of the lower neck, the chest, or even the inside of the fore leg on the opposite side (Plate III, Fig. 5). Whenever the female allows that form of contact, mating will take place within a few minutes. The male eventually stops licking, moves around the female, who stays put, places his chin on her rump and mounts. Out of 24 copulations I have seen in Wilpattu, chest licking occurred in 12 cases. I have seen chest licking only once without witnessing the subsequent copulation, and that was one case where the male was not a big hard (he was a medium hard; i.e. antlers between about 50 and 75 cm long), and where the pair entered the jungle while still courting. Chest licking never occurs at other times. This shows that a female that allows to be licked on the chest signals, to the male as well as to the observer, that she is ready to be mated now, and here.

It is worth noting that in Chital, mutual licking among adults is very rare. It occurs only during courtship. This is very different from some other cervids, most notably the muntjacs (*Muntiacus* sp.), where licking among adults is extremely common (Dubost 1971, Barrette 1977). In addition to vulva, rump, and chest licking by the male, female Chital occasionally lick a courting male's abdomen. This occurs only during an episode of mating, and it may be seen as a form of courtship on the part of a female.

7. *Attempted mount.* Rather often during a courtship sequence a female allows a male to go through the motion of mounting, only to slip forward before he can rest on her back (Plate III, Fig. 6). It often happens in such attempts that the two animals are not perfectly alligned (as on Fig. 6), this being usually a result of the female turning while the male rears behind her. It is usually as a result of the female stepping forward that a male dismounts. It does happen however that a male dismounts on his own from a female standing still, but only to immediately lick her vulva and mount again. A male usually does not walk in an attempt to remain upon a walking female, at the most he makes one or two steps before slipping down.

8. *Mount.* When the female stands perfectly still and the male is well in line behind her, he mounts by sliding his chin from her rump to her wither, flicking his tongue all the while (on Figure 7 his tongue is barely visible). This is different from an attempted mount, the male is far forward on the female, note the difference in the angle that the neck makes with the back compared to Figure 6. In Plate IV, Figure 7, it is a mount with attempted intromission. In any complete sequence of mating, a male mounts many times (mean and S.D. of 20 sequences accurately counted: 5.4 ± 3.1, range 2 to 16), ejaculating only once, on the last of those mounts (see later). The duration of mounts does not vary much, it is usually between 5 and 10 seconds, then the female either walks, more seldom, the male dismounts on his own (or ejaculates). The observation of mounting is not sufficient to conclude that mating is taking place. For one thing, yearling males with spike antlers occasionally mount females in a rather playful manner, and this has nothing to do with mating. Also, a male may go

so rapidly from "chin on rump" to mounting that a female seems to be mounted by surprise, only to strongly resist any subsequent attempts by the male. Finally, it does happen that after over an hour of intense courtship, including even some mounts, a male gives up and does not mate (I observed that 4 times), or even is displaced by another male who does breed the female (see later).

9. *Mount with intromission.* As far as I could see, there seems to be only one mount with intromission per mating sequence. Although I did not measure it, there is a slight difference in the action of the male compared to other mounts. In this mount the male gets faster on the female, and immediately moves far forward (Plate IV, Fig. 8), his muzzle almost touching the female's neck, and his hind legs clasping the female in front of her haunches. The female often seems to lower her wither and tilt backward to press against the male (see her forelegs on Fig. 8).

10. *Ejaculatory thrust.* This is what terminates the last mount in a sequence of mating. From the time the male has achieved the posture seen on Fig 7, to the single forward thrust seen in Plate V, Fig. 9, there is no more than 4 or 5 seconds. It is not really a pelvic thrust that the male performs, but a forward hop: his hind hooves leave the ground and land in front of the female's hind hooves (see Fig. 9 compared to Fig. 7). The female is pushed forward, and can even fall on her "knees" (i.e. carpal joints) as shown on Fig. 9. On occasion, the male rears so high that he can flip over on his back. This unmistakable behavior pattern is considered by all authors to be the moment of ejaculation in Ungulates (e.g. Clutton-Brock *et al.* 1982, Bützler 1974, Barrette 1977, Geist 1981, Buechner & Schloeth 1965). Thus in the latter, this is the only absolutely certain behavioral criterion that mating (i.e. insemination, but not necessarilly fertilization) has taken place. Mounting is not a sufficient criterion. There is only one ejaculatory thrust per sequence of mating, it always ends courtship activity for a rather long interval. I could time the inter-ejaculation interval in a given pair on only four occasions. It lasted an average of 53 minutes (14, 36, 77 and 86). Also, on ten occasions where I observed a mated pair until it went out of sight, they spent on average a minimum of 51 minutes (S.D. = 45, range 7 to 170) without mating again.

11. *Post-copulatory postures and behaviors.* After the ejaculation both partners usually (21 of 24 cases) remain motionless for a while (Plate V, Fig. 10). The male usually moves first, after about 15 seconds. The mean (±S.D.) duration of the female's immobility is much longer (61 ± 28 seconds, range 20 to 120, $n = 9$). During that time the female shows strong abdominal contractions, about once every 20 seconds at which time she seems to strain a lot, her head being lowered and her tail raised at each contraction (the female on Fig. 10 was contracting at that instant). Fluid (presumably semen) often flows out of her vulva during such contractions. Subsequently she walks and resumes grazing or resting. Her tail does not come down in its usual relaxed posture for at least one hour. I considered that a reliable sign that a female has very recently been bred because I know of no other circumstance (except labor maybe) where a female holds her tail stiff, at or near the horizontal for any extended period. The first move that a male performs after ejaculating usually is licking his penis (18 out of 24 cases). The male turns around and takes his penis in his mouth and actively licks it for many seconds (up to 40 seconds in one case). I have seen that repeated up to 3 times in the 4

minutes following ejaculation, but the male usually does it only once. Quite often, right after that, the male yawns. This is believed to be related to lipcurl in bovids (Halder & Schenkel 1972). Afterwards, the male either grazes or rests, and does not resume courtship for many minutes.

Who mates, and is there mate choice by females?

As is usually the case with mammals all female Chital are bred whenever they are in oestrus, from the time they reach sexual maturity and for their whole life. This is simply because a male can inseminate a large number of females in a short time, thus breeding males are never in short supply (see Trivers 1972). The situation is very different with males. Although all males that live long enough will eventually mate, at a given time, it is only a small proportion of the males that do most of the insemination. Thus, at any time, most of the males are denied access to females. This is clearly the case with Chital. The simplest way to recognize classes of males in Chital is on the basis of antler length. I have used the same classes as Schaller (1967) and Fuchs (1977), and I will talk only about hard antlered males here since I never saw velvet antlered males take part in reproduction at all. The first class is that of the yearling males, with short, unbranched antlers called spikes. Branched antlers are worn by adult males, i.e. animals who produce spermatozoa and are thus capable of inseminating females (Fuchs 1977, Graf & Nichols 1966). I recognize three simple classes: small-hards, i.e. the 25 to 50 cm class of Schaller (1967) and Fuchs (1977), medium-hards, i.e. 50 to 75 cm long, and the big-hards, i.e. antlers being 75 cm long or more. Such classes are of course partly arbitrary, but they have some biological significance as well. For one thing they correspond to the animals' age. Small-hards are probably wearing their second and third sets of antlers, i.e. are about 1.5 to 3 years old, medium-hards are animals with their fourth and fifth sets, i.e. 3.5 to 5 years old, and big-hards have probably at least their sixth set of antlers, i.e. are 5.5 years old or older (this is assuming a 12 months antler cycle, and using Graf & Nichols' (1966) observations of known-age Chital; and these age-classes are consistent with those of Fuchs (1977)). Also there is little room for confusion among classes since antler length increases stepwise from year to year, thus most big-hards for instance have noticeably longer antlers than most medium-hards.

Schaller (1967) and Fuchs (1977) have clearly shown that these seemingly arbitrary classes are indeed very different in terms of the frequency with which they perform sexual behaviors. This is certainly true for mating. Of the 24 copulations. I have recorded in Wilpattu, 23 were done by big-hards (see the Figures). I could find reports of 44 copulations by Chital in the literature, these include only cases where authors have related sexual behavior to antler length, and have explicitly distinguished mounting from ejaculatory thrust (Schaller 1967: 2 copulations, Miura 1981: 3 copulations, Fuchs 1977: 39 copulations). Overall, 61 (90%) of the 68 copulations were done by big-hards, 4 by medium-hards, and 3 by small-hards. I have observed one of those copulations by a small-hard, in May 1983 in Wilpattu, and it was an unambiguous copulation, i.e. patterns 6, 9, 10 and 11 were all observed. It differed from all other cases in an important way, however, the male was very aggressive toward the female, repeatedly hitting her on the sides and shoulders with his antlers, something I never saw a big-hard do.

These results show at least two things: small

antlered males can and do inseminate females, but big antlered males, even though they constitute about 30% of the adult males (Schaller 1967, Fuchs 1977, personal observation), do 90% of the copulations. This raises the question of female mate choice. This is a matter best investigated through an experimental approach (see Bateson 1983), but I will report some observations here showing that, in Chital, both inter-male aggression and, to a lesser extent, female preference for some males, explain the disproportionate contribution of big-hards to inseminations.

Inter male aggression is common in Chital. Violent fights, although relatively rare compared to the rather friendly sparring matches witnessed daily, do occur. I have seen 10 such fights in 6 months in 1983, and Fuchs (1977) has recorded 74 instances. Males with antlers broken while hard are not rare (Barrette 1985, Fuchs 1977) and these are certainly the result of male-male fights. In addition to being injured in such fights, males can also be killed. I have recorded one such unambiguous case in Wilpattu. Although such observations are rare, over the entire life time of a given male, injuries caused by fights probably do make a difference in its longevity and vigour, and death through such fights is a distinct possibility (see Clutton-Brock 1982 and Geist 1986).

Contrary to some other species of Ungulates, Axis deer do not fight to defend a territory, nor do they fight to have access to food resources since the latter are abundant and distributed in a rather uniform way, thus making it unnecessary to fight for them (see Jarman 1974). It is therefore commonly stated that in such a situation males fight in order to gain access to females. But what one usually sees is only that some do more copulations than others, actual observations of males fighting over an oestrus female are very rare. I have witnessed 4 unambiguous cases where a courted female was actually taken away from a male by another one. In two of them it was done without aggression, the courting male simply moving away from the female at the rivals' approach, and letting him do the courtship in his turn. In the other two cases the males fought and the newcomer left with the female. In all four cases I did not see the animals mate after the takeover and there was no evidence that mating was imminent. Therefore, the simplest interpretation of what happened is that the male *took* the female, not that the female *chose* one male over the other.

Here is the description of one such case that happened at Timbiri villu (about 400 m across) on August 7, 1983 between 09h46 and 10h11. "On this side of the villu, 40 deer were grazing and resting. Among them were 7 large males (# 5 and 15 who have recently cast their antlers, and the big-hards # 1, 11, 12, 45 and 48). Number 12, 45 and 48 were actively courting females. From the other side of the villu a group of 15 Axis came out of the forest. Among them was big-hard # 41. At the edge of the forest 41 bellowed once, then left his group and approached the group of 40. From about 50 m, 41 started a fast walk toward big-hard 48 who was courting and guarding a female at that instant. When 41 was at some 10 m, 48 turned to face him, they clashed head-on and fought violently for about 15 s. During the fight, big-hard, 11, who, up to now had been ignoring the courtship activity going on in the group, walked to the female 48 was courting, and herded her away from the group, licking her vulva. Male 41 won the fight against 48, and chased him over a short distance, only to return to his female right away. From about 50 m, 41 started a fast walk again toward 11 and the female. Male 11 stopped licking the female and looked over his shoulder at 41 coming. When the latter was

about 10 m away, male 11 quickly lowered his head, turned and walked a short distance away from the female. Male 41 stopped and, looking around, he horned the ground a little and walked with head low, sniffing the ground about 20 m from the female. In the meantime, male 11 had returned to the female and was licking her vulva. Male 41 started a fast walk toward the pair, male 11 turned, faced male 41, they clashed, and fought for about 10 s. Male 11 slipped backward, 41 kept pushing hard, 11 veered and ran off, 41 pursued him over a short distance. Then 41 returned to the female, licking her vulva, he trailed her constantly as she was walking away from him, once he hit her rump with his forehard, herding her away from the group. She stopped a few s to drink, 41 standing behind her. Then 41 kept trailing her toward the forest where they entered, alone. Both males 11 and 48 remained in the open, grazing within the group".

That 25-minute event shows only that male Axis do fight over females, and that winning such a fight gives at least a momentary priority of access to the contested female. A male that consistently won such fights could thus considerably improve his reproductive success (see Clutton-Brock *et al.* 1982). The second example I want to describe shows the same thing, but here, in addition, the female seems to prefer one male. It happened on July 31st 1983 at Maha Patessa (about 600 m across). Big-hard 40 had been actively guarding and courting a female in and around a group of 16 deer. He constantly attempted to approach her and succeeded only occasionally to touch her vulva with his muzzle, everytime she lunged ahead to resume grazing, while the male stopped, either did a lipcurl, or instantly jerked back to attention in the guarding posture. On three occasions male 40 rushed at the female who then ran off with the male in hot pursuit behind her all the way across the villu. Everytime that she stopped, so did he, guarding her some more. This went on non-stop for 45 minutes. At that time, big hard 11 came out of the forest on the far side of the villu, about 300 m from the pair and the group. This males antlers are noticeably longer and spread wider than those of male 40. He walked slowly straight toward the pair, walking in a seemingly relaxed manner, never showing any kind of display. When he got at about 30 m from the pair, male 40 seemed to notice him for the first time, he looked at him, still approaching slowly in an absolutely neutral posture, the female was grazing. When male 11 got at about 10 m from them, male 40, in the very appropriate wordings of Krishnan (1972: 493), showed "a sudden preoccupation with grazing"! He seemed to instantly loose all interest in the female, and started grazing actively, walking away from the female. Male 11 walked straight to the female, immediately licked her vulva, then her chest and face and belly; the female walked a few steps, not away, but around male 11; the latter mounted her, she walked ahead, he mounted her 4 more times, ejaculating on the last mount."

At least three things presumably happened here: male 40 immediately recognized male 11 as a rival he should yield to, even when not threatened by him; male 11 also recognized male 40 as a rival that there was not even any point threatenning; and, most importantly the female clearly seemed to prefer male 11 to male 40. How else could one explain that she would so totally resist to male 40's intense and constant courtship, only to copulate with male 11 after the most abreviated sequence of courtship I ever saw? I can see only two alternatives: either the female suddenly became receptive at the exact minute that male 11 arrived; or male 40 did all the, lets imagine, necessary, foreplay, only to have

to relinquish the indifferent female to the large male. These are two alternatives that seem much more unlikely than mate preference on the part of the female.

Conclusion

Female mate choice is not easy to observe in nature (see Bateson 1983), let alone study it quantitatively. Clutton-Brock (1982) doubts that it occurs in red deer (*Cervus elaphus*), but Moss (1983) has shown it to occur in the African elephant (*Loxodonta africana*). Mate choice by a female clearly seems the most likely interpretation in the case above. In all, I saw three such cases. In absolute terms this may seem a very small number of observations. But it must be remembered that in 20 months of field work in an area where over 200 (and up to 1000) Axis could be seen on most days, I recorded only 24 copulations. In that context, 3 cases does not seem such a rare event. This indicates I think, that female mate choice may be an important phenomenon in Axis deer. Such discrimination by females may make an important contribution to the fact that small-hards and medium-hards do a very small proportion of the matings. Whatever the case may be, it is through careful and repeated observations of freely interacting animals that a phenomenon as important and subtle as mate choice may come to be demonstrated and understood (see Cox 1981). And of course the minimum basis of such observations is an adequate knowledge of the sexual repertoire of a species. It is particularly necessary to discriminate unambiguously mating from attempted mating, and to recognize mating on the basis of the imperfect observations often unavoidable in the field. This is my purpose in presenting such information on the Axis deer, a polygynous mammal where intermale competition for access to females can be intense, and where female mate choice is likely.

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MATERIAL FOR THE FLORA OF MAHABALESHWAR—8

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[*Continued from Vol. 83*(3): 602]

Poaceae (= Graminae)

(All keys have been adopted from N. L. Bor, Grasses of Burma, Ceylon, India and Pakistan, 1960)

1. Shrubs or trees with woody, often tall, persistant culms; leaflets with a petiole like base which is articulated with the sheath 2
   2. Pericarp thin, adnate to the seed 3
      3. Filaments free .... *Bambusa*
      3. Filaments adnate or connate 4
         4. Stamens 3 .... *Arundinaria*
         4. Stamens 6 .... *Oxytenanthera*
   2. Pericarp fleshy or crustaceous; seeds free .... *Dendrocalamus*
1. Annual or perrenial herbs; leaf-blade not articulated with the sheath 5
   5. Spikelets 2-flowered, falling entire at maturity, usually with the upper floret hermaphrodite and the lower male or barren and if the latter, then often reduced to the lemma or rarely the lemma entirely absent 6
      6. Spikelets all hermaphrodite, or with male or barren and hermaphrodite spikelets mixed in the same inflorescence and so arranged that a male or barren spikelet, or if unisexual then the lemma of the fertile floret indurated 7
         7. Spikelets often paired with one sessile and other pedicelled, rarely solitary, all alike; glumes as long as the spikelet and enclosing the florets, more or less rigid and firmer than the lemmas, which are both hyaline of membranaceous; upper lemma usually awned 8
            8. Spikelets solitary .... *Dimeria*
            8. Spikelets in pairs or in threes 9
               9. Spikelets in each pair similar 10
                  10. Spikelets in simple racemes .... *Eulalia*
                  10. Spikelets in panicles or in compound racemes 11
                      11. Spikelets unawned .... *Saccharum*
                      11. Spikelets awned .... *Spodiopogon*
               9. Spikelets in each pair dissimilar 12
                  12. Joints of the rhachis and pedicel of pedicelled spikelet swollen or much reduced, 3-angled, rounded or flattened 13
                      13. Sessile spikelet with a male and hermaphrodite floret; upper lemma awned 14
                          14. Racemes many noded, not covered in sheath 15
                              15. Raceme solitary .... *Sehima* (p.p.)
                              15. Racemes two to many .... *Ischaemum*
                          14. Raceme one noded, enclosed in a sheath .... *Apluda*
                      13. Sessile spikelets with only hermophrodite floret or occasionally a male floret below, upper lemma unawned 16
                          16. Sessile spikelet spherical .... *Hackelochloa*
                          16. Sessile spikelets not spherical 17

17. Sessile spikelet winged; glumes perforated or sculptured ... *Manisuri's*
17. Sessile spikelet not winged; glume not perforated or sculptured .... *Ophiuros*

12. Joints of the rhachis and pedicels narrow, seldom thickened upwards, occasionally with a transluscent groove; sessile spikelet usually awned 18

18. Inflorescence a terminal simple raceme .... *Sehima* (p.p.)
18. Inflorescence a panicle or compound racemes 19
19. Spikelets in racemes which are not interrupted by spathes 20
20. Lower glume tuberculate; spikelets in whorls .... *Vetiveria*
20. Lower glume not tuberculate; spikelets not in whorls .... *Chrysopogon*
19. Spikelets in panicles of racemes which are interrupted by spathes, or espathate racemes digitate 21
21. Upper lemma of the sessile spikelet with a basal awn .... *Arthraxon*
21. Upper lemma of the sessile spikelet with awn from the tip or from the cleft or reduced to the hyaline base of the awn 22
22. Awn glabrous 23
23. Racemes surrounded at the base by an involucre of spikelets 24
24. Involucral spikelets pedicellate, deciduous. .... *Iseilema*
24. Involucral spikelets sessile, not deciduous. .... *Themeda*
23. Racemes without an involucre 25
25. Racemes straight or slightly curved; lower glume of sessile spikelets hairy .... *Pseudodichanthium*
25. Racemes markedly curved; lower glume of sessile spikelets glabrous .... *Pseudodichanthium*
22. Awn hairy 26
26. Upper lemma of the sessile spikelets not cleft 27
27. Spikelets at the tips of the capillary branches .... *Capillipedium*
27. Spikelets not at the tip of the capillary branches 28
28. Joints and pedicels with a transluscent longitudinal furrow .... *Bothriochloa*
28. Joints and pedicels not with transluscent furrow 29
29. All pairs of spikelets heterogamous; upper lemma of the sessile spikelet bifid.. *Pseudosorghum*
29. Lower 1-3 spikelets homogamous; upper lemma of the sessile spikelet reduced to the transluscent base of the awn 30
30. Lower 1-3 spikelets homomorphous .... *Indochloa*
30. All spikelets alike .... *Dichanthium*
26. Upper lemma of the sessile spikelet 2-lobed or two cleft .... *Cymbopogon*

7. Spikelets solitary or paired, similar, the lower glume is smaller than the upper or rarely suppressed; upper lemma usually awnless 31
31. Spikelets mucronate or awned .... *Rhynchelytrum*
31. Spikelets unawned 32
32. Spikelets falling singly, not subtended by bristles (or if so, then the bristles persisting after the spikelets have fallen) 33
33. Spikelets arranged in more or less open panicles or with the panicles contracted and spike-like 34
34. Bristles subtended or replaced by one to many bristles like branchlets which remain after the spikelets have fallen .... *Setaria* (p.p.)
34. Spikelets not subtended by bristle-like branches 35
35. Spikelets usually arranged in cylindrical spike-like panicles; upper glume inflated or not .... *Sacciolepis*

35. Spikelets arranged in open or contracted panicles 36

36. Spikelets not or only slightly gibbose .... *Panicum*

36. Spikelets distinctly gibbose and laterally compressed .... *Cyrtococcum*

33. Spikelets arranged in one sided spikes or spike-like racemes, digitate or scattered 37

37. Lemma of the upper floret thinly cartilaginous, usually with flat hyaline margin .... *Digitaria*

37. Lemma of the upper floret more or less crustaceous or coriaceous, usually with narrow inroled margins 38

38. Spikelets adaxial .... *Brachiaria*

38. Spikelets abaxial 39

39. Lower glume usually absent; spikelets plano-convex .... *Paspalum*

39. Lower glume present 40

40. Leaf-blade linear; racemes dense; culms erect or suberect .... *Echinochloa*

40. Leaf-blades lanceolate or ovate; racemes loose or moderately dense; culms creeping and ascending .... *Oplismenus*

32. Spikelets with an involucre of bristles or subtended by a solitary bristle and falling with or without the bristles at maturity 41

41. Upper lemma smooth; bristles caducous .... *Pennisetum*

41. Upper lemma transversly rugose; bristles persistant .... *Setaria* (p.p.)

6. Male and female spikelets in separate inflorescence or in different parts of the same inflorescence and of different appearance; lemmas hyaline or membranaceous and thinner than the glumes ... 42

42. Female spikelets not enclosed in a false involucral sheath 43

43. Female spikelets not crowded; axis thin 43A

43A. Lower glume of female spikelet 3-lobed, central lobe larger .... *Trilobachne*

43A. Lower glume of female spikelet not 3-lobed, central lobe not larger .. *Chionachne*

43. Female spikelets in crowded longitudinal rows on a very thin axis .... *Zea*

42. Female spikelets completely enclosed in a false involucral sheath .... *Coix*

5. Spikelets one to many flowered, breaking at maturity above the more or less persistent glumes, or if falling entire then not two flowered, with lower floret male or barren and the upper floret hermaphrodite 44

44. Spikelets usually with two or more fertile florets (if with one fertile floret then sterile reduced floret above it) 45

45. Glumes usually as long as or longer than the lowest floret .... *Avena*

45. Glumes usually shorter than the lowest floret 46

46. Spikelets in terminal, solitary secund spike .... *Tripogon*

46. Spikelets not in solitary spikes 47

47. Inflorescence of panicles 48

48. Spikelets in digitate or subdigitate panicles .... *Eleusine*

48. Spikelets in open, contracted or spike-like panicles 49

49. Stamens 2; ligule membranaceous .... *Eragrostis*

49. Stamens 3; ligule ciliate .... *Chloris* (p.p.)

47. Inflorescence of racemes or panicles of racemes, the spikelets secund 50

50. Imperfect florets absent .... *Cynodon*

50. Imperfect florets present .... *Chloris* (p.p.)

44. Spikelet with one fertile floret 51

51. Glumes minute or suppressed; fertile lemmas and paleas similar .... *Oryza*

51. Glumes developed; fertile lemmas and paleas dissimilar 52

52. Spikelets with 3-florets .... *Phalaris*

52. Spikelets with 1-2 florets 53

53. Spikelets with 2-florets 54

54. Lower floret without palea .... *Thysanolaena*

54. Lower floret with palea 55

55. Glumes equal in size.......... 56

56. Upper lemma becoming indurated; glumes finally deciduous ... *Isachne*
56. Upper lemma remaining membranaceous; glumes persistent .. *Coelachne*
55. Glumes unequal in size 57
57. Lemma of the upper floret bearded on the dorsal surface .... *Jansenella*
57. Lemma of the upper floret scabrid .... *Arundinella*
53. Spikelets with one fertile floret 58
58. Base of the glume bearded .... *Garnotia*
58. Base of the glume not bearded 59
59. Spikelets solitary at each node of the spike axis .... *Triticum*
59. Spikelets more than one at each node of the spike axis .... *Hordeum*

Apluda Linn.

1. **Apluda mutica** Linn. Sp. Pl. 82, 1753; Bor, Grasses, Burma, Ceylon, India & Pakistan, 93, 1960.

A aristata Linn. Cent. Pl. 2: 71, 1756; Birdwood. 31.

A. varia var. *aristata* Hack. in DC. Mon. Phan. 6: 196, 1889; Blatter & McCann, Bombay Grasses 29, t. 20, 1934.

A. varia Hack. Mon. Andropog. in DC. Mon. 6: 196, 1889; Cooke, 2: 956 (3:474).

A variable monsoon species found in semi-shaded places and along hedges, where it sometimes assumes a climbing habit.

DISTRIBUTION: Lingmala, Fitzgerald Ghat, Chinaman's falls.

FLOWERS: October-December.

VERN. NAMES: Bangrat, Ghagra.

Arthraxon P. Beauv.

1. Spikelets long awned; awn 15-25 cm long .... *A. jubatus*
1. Spikelets short awned, less than 2.5 cm long 2
2. Lower glume of sessile spikelet densely villous; keels with narrow densely ciliate wings .... *A. villosus*
2. Lower glume of sessile spikelets at most puberulous 3
3. Spikelets laterally compressed; lower glume of sessile spikelets not keeled 4
4. Pedicelled spikelets at least in the upper part of the raceme developed .... *A. lancifolius*
4. Pedicelled spikelets not developed 5
5. Stamens 2 .... *A. hispidus*
5. Stamens 3 6
6. Pedicals absent or microscopic .... *A. inermis*
6. Pedicals upto 2 mm. long, slender .... *A. nudus*
3. Spikelets not laterally compressed 7
7. Keels of the upper glume with penicellate tubercles upwards .... *A. meeboldii*
7. Keels of the upper glume without penicillate tubercles 8
8. Root-stock and sheath not tomentose .... *A. echinatus*
8. Root-stock and sheath covered with silky cataphylls .... *A. lanceolatus*

1. **Arthraxon echinatus** (Nees) Hochst. in Flora, 39: 188, 1856; Birdwood, 30; Bor 99.

Bathratherum echinatum Nees, in Edinb. New Phil. J. 18: 181 1835.

Arthraxon spathaceus Hook. f. Fl. Brit. India. 7: 145, 1896.

This species mentioned here on authority of Birdwood. We have not seen authentic specimen of this species from Mahabaleshwar.

2. **Arthraxon hispidus** (Thunb.) Makino, in Bot. Mag. Tokyo, 26: 214, 1912; Bor, 99.

Phalaris hispida Thunb. Fl. Japan, 44, 1784.
A. ciliaris Beauv. Agros. 111, t. 11, f. 6, 1812; Cooke 2: 970 (3: 489).

A common grass on embankments and on old walls.

FLOWERS: October.

3. **Arthraxon inermis** Hook. f., in Fl. Brit. India, 7: 145, 1896; Cooke, Fl. Bombay 2: 968 (3: 487); Blatter & McCann. 74, t. 45; Puri & Mahajan, 135; Bor, 100.

A quite common grass in semi-shaded forest areas.

FLOWERS: October.

VERN. NAME: Vanguarin (T. Cooke).

4. **Arthraxon jubatus** Hack. in DC., Monogr. Phan. 6: 358, 1889; Cooke: 2: 970 (3: 489); Blatter & McCann, 79, t. 50; Bor, 100.

This species is very common along water courses and by the sides of water-falls, all over Fitzgerald ghat. It is one of the prominent species with long curved awns.

FLOWERS: October.

5. **Arthraxon lanceolatus** (Roxb.) Hochst. in Flora 39: 188, 1856; Birdwood, 30, Cooke, 2: 968 (3: 487); Bor 100.

Andropogon lanceolatus Roxb. Fl. Ind. 1: 262, 1820.

A tall species reaching upto 3 ft in height. We have not seen this grass in Mahabaleshwar or in any of the herbaria visited. It is included here on the authority of Birdwood.

FLOWERS: October.

VERN. NAMES: Harjala, Govinder.

6. **Arthraxon lancifolius** (Trin.) Hochst. in Flora 39: 188, 1856; Blatter & McCann, 77, t. 48; Bor, 100.

Bathratherum molle Nees et Arn. in Edinb. New Phil, J. 18: 181, 1835.
Andropogon lancifolius Trin. in Mem. Acad. Sci. Petersb. Ser. 6, 2, 271, 1832.
A. molle Balf. in Trans. Roy. Soc. Edinb. 31: 315, 1888; Birdwood, 30.

Very common species found on old walls, eroded surfaces and on waste lands.

We have not seen a specimen belonging to this species in any herbaria. Included here on the authority of Birdwood.

FLOWERS: September.

7. **Arthraxon meeboldii** Stapf in Kew Bull. 449, 1908; Cooke, 2: 969 (3: 488); Blatter & McCann, 76, t. 47; Puri & Mahajan, 136; Bor, 101.

A very common and abundant grass on higher elevations, (600-1500 m.).

FLOWERS: September.

8. **Arthraxon nudus** (Steud.) Hochst. in Flora 39: 188, 1856; Bor, 101.

Bathratherum nudum Nees ex Steud., Syn. Pl. Glum. 1: 383, 1854.

A rare grass along margins of forest in partially shaded places.

DISTRIBUTION: Chinaman's falls, Lodwick point.

FLOWERS: September-October.

9. **Arthraxon villosus** C.E.C. Fisher, in Kew Bull. 1933; 350, 1933; Bor, 103.

Rare grass at Lodwick point, known from a single collection from Mahabaleshwar.

FLOWERS: October.

Arundinaria Michx.

1. **Arundinaria wightiana** Nees in Linnaea 9: 482, 1834; Lisboa, 224.

This species is reported here on authority of Lisboa.

VERN. NAME: Chivari.

Arundinella Raddi

1. Upper floral glume with 3 awns 2
   2. Inflorescence densely spicate .... *A. spicata*
   2. Inflorescence not spicate, either paniculate or racemose. 3
      3. Upper lemma with 2 setae, one on either side of the awn. .... *A. setosa*
      3. Upper lemma without setae 4
         4. Spikelets less than 2 mm long; leaf-blades elliptic-acuminate .... *A. pumila*
         4. Spikelets over 2 mm long; leaf-blades not elliptic-acuminate 5
            5. Spikelets glabrous or with a few short hairs on the keels of the glumes 6
               6. Perennial grasses .. *A. nepalensis*
               6. Annual grasses ...... *A. metzii*
            5. Spikelets very bristly from tuberculate base hairs on the nerves of the glumes and/or on the interspaces or atleast the bases of the bristles remaining 7
               7. Panicles very effuse and drooping; glumes unequal ..... *A. metzii*
               7. Panicles usually compact; rather effuse then glumes more or less equal .... *A. ciliata*
1. Upper floral glume awnless ...... *A. leptochloa*

1. **Arundinella ciliata** (Roxb.) Nees ex Miq. in Vesh. Konink. Nederl. Inst. 3(4): 30, 1851; Puri & Mahajan, 136; Bor. 421.

Holcus ciliatus Roxb. Fl. Ind. 1: 321, 1820.

We have not seen this species from Mahabaleshwar. Blatter & McCann have not reported it in Bombay Grasses from Mahabaleshwar. We include it here on authority of Puri & Mahajan.

2. **Arundinella leptochloa** (Nees ex Steud.) Hook. f. Fl. Brit. Ind. 7: 76, 1896; Bor, 423.

Panicum leptochloa Nees ex Steud. Syn. Pl. Glum. 1: 62, 1854.

Arundinella gigantea Dalz. in Dalz. & Gibs. Bombay Fl. 293, 1861; Cooke, 2: 1005 (3: 525).

Common grass along the margins of the forests. Very variable species.

FLOWERS: October.

3. **Arundinella metzii** Hochst. ex Miq. in Verh. Konink. Noderl. Inst. 3(4) 31, 1851; Cooke, 2: 1003 (3 523); Bor, 423.

A. lawii Hook. f. in Trin. Hand. Fl. Ceylon 5: 180, 1900; Cooke, 2: 1003 (3: 523).

Quite common species on embankments along forest paths and on road-sides.

FLOWERS: October-November.

4. **Arundinella nepalensis** Trin. Gram. Panic. 62, 1826; Bor, 423.

A. brasiliensis Hook. f. in FBI 7: 73, 1896 (non Raddi 1823); Cooke 2: 1003 (3: 524); Puri & Mahajan, 136.

A. hispida Blatter & McCann, Bombay Grasses, 195, 1934 (non O. Kuntze, 1891); Puri & Mahajan, 136.

A variable grass usually found along the sides and in beds of streams and rivers.

FLOWERS: October-November.

5. **Arundinella pumila** (Hochst.) Steud. Syn. Pl. Glum. 1: 114, 1854; Cooke, 652; Bor 423.

A. tenella Nees ex Steud. Syn. Pl. Glum. 1: 115, 1854; Dalz. & Gibs. 292; Cooke 2: 1001 (3: 522); Blatter & McCann, 193, t. 127; Puri & Mahajan, 136.

Acratherum pumilum Hochst. ex A. Rich., Tent. Fl. Abyss. 2: 414, t. 100, 1851.

Common monsoon grass along the forest borders and in semi-shaded forests. Usually occurs on old walls or on rocks.

DISTRIBUTION: Lingmala, Chinaman's point, Lodwick point.

FLOWERS: September-November.

6. **Arundinella setosa** Trin. Gram. Panic. 63, 1826; Bor, 424-5.

A. stricta Hook. Kew Journ. Bot. 2: 102, 1850; Dalz. & Gibs. 293; Cooke, 1001 (3: 521); Birdwood, 30.

This species is reported on authority of Birdwood and Cooke. We have not seen a specimen of this species from Mahabaleshwar; not reported by Blatter & McCann also.

VERN. NAME: Kotir (Turdia?).

7. **Arundinella spicata** Dalz. in Dalz. & Gibs. Bombay Fl. 293, 1861; Cooke, 652 & 2: 1004 (3: 525); Birdwood, 30; Puri & Mahajan, 136; Bor, 425.

A common and abundant grass in latter part of monsoon, in open grass-lands. In appearance it very much resembles *Setaria* spp.

DISTRIBUTION: Yenna Banks, Lodwick point.

FLOWERS: October-November.

VERN. NAMES: Benel, Kotir.

Avena Linn.

1. **Avena sativa** Linn. Sp. Pl. 79, 1753; Birdwood, 31; Cooke, 2: 1051 (3: 574); Bor, 434.

We have not seen reliable specimen from Mahabaleshwar. It is included here on the authority of Birdwood.

VERN. NAME: Jao.

Bambusa Schreb.

1. **Bambusa arundinacea** Willd. Sp. Pl. 2: 245, 1799; Cooke, 2: 1046 (3: 569); Birdwood, 31; Holttum, Taxon 5: 67, 1956.

Bambusa bambos (Linn.) Voss. in Vilm. Blumeng. 1: 189, 1896.

Bambusa arundo Klein et Nees, in Linnaea 9: 471, 1834; Dalz. & Gibs. 299; Birdwood, 31.

Arundo bambos Linn. Sp. Pl. 81, 1753; (non conf. see Holtt. Taxon 5: 67, 1956).

Common tree grass in ghat area and at Lingmala.

VERN. NAME: Kalak.

2. **Bambusa vulgaris** Schrad. in Wendl. Collect. 2: 26, t. 47, 1810; Cooke, 2: 1047 (3: 57); Birdwood, 31.

Common bamboo cultivated in private compounds.

Bothrichloa O. Kuntze

1. Lower racemes longer than the rhachis.................................... *B. concanensis*
1. Lower racemes shorter than the rhachis .... *B. odorata*

1. **Bothriochloa concanensis** (Hook. f.) Henrard, in Blumea 3: 457, 1940; Bor, 106.

Andropogon concanensis Hook. f. in FBI 174, 1896; Cooke, 2: 980 (3: 499).

Amphilophis concanensis (Hook. f.) Blatter & McCann in Journ. Bombay nat. Hist. Soc. 32: 422, 1928.

Occasional in wet ground, water logged fields and along water courses.

FLOWERS: November.

2. **Bothriochloa odorata** (Lisboa) A. Camus, Ann. Soc. Linn. Lyon 1930, n.s. 76: 165, 1931; Bor, 109.

Andropogon odoratus Donna Lisboa, Journ. Bombay nat. Hist. Soc. 4: 123, 1889; Cooke, 2: 981 (3: 500).

Rare species with aromatic oil. It is reported here on the authority of Lisboa. We have not seen any specimen from Mahabaleshwar.

Brachiaria Griseb.

1. Spikelets less than 2 mm long; panicles not linear; lower glume upto ½ as long as spikelet .... *B. reptans*
1. Spikelets more than 3 mm long; panicles linear; lower glume a minute (0.3 mm) scale .... *B. cruciforme*

1. **Brachiaria cruciforme** (J. E. Sm.) Griseb. in Ledeb., Fl. Ross. 4: 469, 1853; Bor, 283.

Panicum cruciforme J. E. Sm. in Siebth. et J.E. Sm. Fl. Graeca 1: 44, t. 59, 1806; Birdwood, 30.

P. isachne Roth. Nov. Pl. Sp. 54, 1821; Cooke 2: 931 (3: 448).

This species is reported here on authority of Birdwood. We have not seen any authentic specimen from Mahabaleshwar.

VERN. NAMES: Shimpi, Wag-hast (Birdwood).

2. **Brachiaria reptans** (Linn.) Gard. et C. E. Hubb. in Hook. Icon. Pl. sub. 3363, 1938; Bor, 285.

Panicum reptans Linn. Syst. Nat. (ed. 10) 870, 1759.

P. prostratum Lamk. Tab. Encycl. Meth. Bot. 1: 171, 1791; Cooke, 652 & 932 (3: 448); Birdwood, 30.

This species also reported from Mahabaleshwar by Birdwood. We have not seen any authentic specimen from Mahabaleshwar.

Capillipedium Stapf

1. Culms weak, decumbent and trailing, much geniculately branched .... *C. filiculme*
1. Culms erect, robust, simple or branched 2
   2. Nodes glabrous or shortly hairy; callus shortly bearded; panicles often somewhat open .... *C. assimile*
   2. Nodes densely bearded; callus villosely bearded; panicles contracted ..... *C. hugellii*

1. **Capillipedium assimile** (Steud.) A. Camus in Lemonte, Fl. Gen. de l'Indo-Cine 7: 314, 1922; Bor 110.

Andropogon assimilis Steud. in Zll. Syst. Verz. 58, 1854; Cooke, 2: 981 (3: 501).

Common and gregarious woody grass on hill-slopes along road-sides.

DISTRIBUTION: Pratapgadh Road.

FLOWERS: November.

2. **Capillipedium filiculme** (Hook. f.) Stapf, in Hook. Icon. Pl. Sub. tab. 3085, 1922; Blatter & McCann, 821; Bor, 111.

Andropogon filiculmis Hook. f., FBI 7: 181, 1896; Cooke, 2: 982 (3: 502).

Weak trailing grass usually found among the bushes, producing long stilt roots from nodes.

FLOWERS: November.

3. **Capillipedium hugellii** (Hach.) A. Camus, Rev. Bot. Appl. 1(4): 306, 1921; Blatter & McCann, 81, t. 52; Bor, 111.

Andropogon hugellii Hack. in DC. Mon. 6: 492, 1889; Cooke, 2: 892 (3: 501).

A. foetidus Donna Lisboa ex Lisboa, J. Bombay nat. Hist. Soc. 6: 205, 1891.

Common grass on hill slopes and along the margins of forests all over. Inflorescence when crushed emits strong smell very often inducing headache.

FLOWERS: July-October.

4. **Capillipedium parviflorus** (R. Br.) Stapf in Prain, Fl. Trop. Africa 9: 169, 1917; Bor, 112.

Holcus parviflorus R. Br. Prodr. 199, 1810.

There is one specimen of this species in Blatter Herbarium collected by L. J. Sedgwick from Mahabaleshwar except which it is confined to Northern India only.

Chionachne R. Br.

1. **Chionachne koenigii** (Spreng.) Thw. Enum. Pl. Zeyl. 357, 1864; Bor, 262.

Coix koenigii Spreng. Syst. 1: 239, 1825.

This species is known from a single collection from Fitzgerald ghat collected by Charles McCann (3599).

FLOWERS: September-October.

Chloris Sw.

1. **Chloris barbata** Sw. Fl. Ind. Occ. 1: 200, 1797; Birdwood, 31; Cooke 2: 2: 1035 (3: 557); Bor, 465.

This species is reported here on authority of Birdwood. We have not seen any specimen of this species, from Mahabaleshwar.

VERN. NAME: Goshya (Birdwood).

Chrysopogon Trin.

1. **Chrysopogon aciculatus** (Retz.) Trin., Fund. Agrost. 188, 1820; Bor, 115.

Andropogon aciculatus Retz., Obs. Bot. 5: 22, 1789; Cooke 2: 984 (3: 504).

Common grass in pastures in plains. Known from only one collection from Mahabaleshwar.

FLOWERS: October.

Coelachne R. Br.

1. Plants less than 10 cm tall, erect ..... *C. minuta*
1. Plants more than 20 cm tall, spreading .... *C. simpliciuscula*

1. **Coelachne minuta** Bor, in Journ. Bombay nat. Hist. Soc. 58: 1317, 1961.

Rare species in moist water-logged places, which is described from Mahabaleshwar as its type locality.

FLOWERS: August-November.

2. **Coelachne simpliciuscula** (Wt. et Arn.) Munro ex Benth. in J. Linn. Soc. (Bot.) 19: 93, 1881; Bor, 576.

Panicum simpliciusculum Wt. et Arn. ex Steud. Syn. Pl. Glum. 1: 96, 1854.

C. pulchella Hook. f. Fl. Brit. India, 7: 270, 1896 (non R. Br. 1810).

A very variable species growing in marshy places. It is quite common in open grasslands during monsoon when water is abundant.

FLOWERS: December-January.

Coix Linn.

1. **Coix lachryma-jobi** Linn. Sp. Pl. 972, 1753; FBI 7: 100; Cooke 2: 997 (3: 517); Blatter & McCann 3, t. 1; Bor, 264.

C. lachryma Linn. Syst. (ed. 10) 1261, 1759; Birdwood, 30.

This species is included here on authority of Birdwood.

VERN. NAMES: Kasai, Ran-maka (Birdwood).

Cymbopogon Spreng.

1. **Cymbopogon martinii** (Roxb.) Wats, in Atkins, Gaze. N.W. Prov. India, 392 1882; Blatter & McCann, 104; Bor, 129.

Andropogon martinii Roxb. Fl. Ind. 1: 280, 1820.

A. shoenanthus Birdwood, Catalogue Pl. Matheran and Mahabaleshwar, 30, 1897 (non Linn. 1753); Cooke, 2: 991 (3: 511).

Common grass in open grass-lands. The grass contains geraniol and has strong odour. Oil expressed from this grass is known as Palmarosa oil.

FLOWERS: October-December.

Cynodon Rich.

1. **Cynodon dactylon** (Linn.) Pers. Syn. Pl. 1: 85, 1805; Cooke, 652 (3: 554); Birdwood, 31; Blatter & McCann, 250, t. 166; Bor, 469, f. 52.

Panicum dactylon Linn. Sp. Pl. 58, 1753; Graham, 236.

Common and abundant grass all over which forms the natural lawns in open grass-lands. It is a sacred grass for local people and used in worship of deities.

FLOWERS: Throughout the year.

VERN. NAMES: Hariyali, Darb, Durva.

Cyrtococcum Stapf

1. **Cyrtococcum oxyphyllum** (Steud.) Stapf, in Hook., Ic. Pl. sub tab. 3096, 1922; Bor, 291.

Panicum oxyphyllum Steud., Syb. Pl. Glum. 1: 65, 1854.

A rare grass in damp shady places in forests among the undergrowth.

FLOWERS: October.

Dendrocalamus Nees

1. **Dendrocalamus strictus** Nees, in Linnaea, 9: 476, 1834; Cooke 2: 1049 (3: 570); Birdwood, 31.

Rarely cultivated bamboo with solid culms.

Diandrochloa de Winter

1. **Diandrochloa japonica** (Thunb.) Henry, in Bull. Bot. Surv. India, 9 (1-4): 290, 1967.

Poa japonica Thunb. Fl. Jap. 51, 1784.

Eragrostis interrupta Cooke Fl. Bombay Pres. 2: 1024 (3: 546), 1908; Blatter & McCann, Bombay Grasses, 233, 1935 (non Beauv. 1812).

E. japonica (Thunb.) Trin. in Mem. Acad. Sci. Petusb. Ser. 6, 1: 405, 1831; Bor, 509.

Rare grass in grass-lands.

FLOWERS: August.

Dichanthium Willemet

1. **Dichanthium caricosum** (Linn.) A. Camus, in Bull. Mus. Hist. Nat. Paris, 27: 549, 1921; Bor, 134.

Andropogon caricosum Linn. Sp. Pl. ed 2, 1480, 1763; Cooke 2: 987 (3: 507).

Gregarious plant in grass-lands and along road-sides.

FLOWERS: October-November.

Digitaria Heist. ex Fabr.

1. Hairs on the spikelets verrucose .. *D. longiflora*
1. Hairs on the spikelets not verrucose 2
    2. Hairs on the spikelets clavate or absent 3
        3. Spikelets less than 1.25 mm long .... *D. stricta*
        3. Spikelets more than 2.25 mm long .... *D. ternata*
    2. Hairs on the spikelets not clavate .. *D. ciliaris*

1. **Digitaria ciliaris** (Retz.) Koel. Desr. Gram. Gatha et Germania 27, 1802.

Panicum ciliare Retz. Obz. 4: 16, 1786.

P. adscendens H.B.K. Nov. Gen. et Sp. Pl. 1: 97, 1816.

D. adscendens (H.B.K.) Henr. in Blumea 1: 92, 1934.

D. marginata var. *fimbriata* (Link.) Stapf, Fl. Trop. Africa, 9: 440, 1919; Blatter & McCann, 125, t 78.

D. sanguinalis var. *ciliaris* Prain, Beng. Pl. 1181, 1903; Cooke, 2: 940 (3: 457).

An ascending grass common and abundant all over.

FLOWERS: September-November.

2. **Digitaria longiflora** (Retz.) Pers., Syn. Plant. 1: 85, 1805; Cooke, 2: 941 (3: 458); Blatter & McCann, 127, t. 81; Bor, 302.

Paspalum longiflorum Retz. Obs. Bot. 4: 15, 1786.

Rare grass on rocky grounds near Wilson point.

FLOWERS: August.

3. **Digitaria stricta** Roth ex Roem. et Schult., Syst. Veg. 2: 474, 1817; Bor, 305.

Agrostis pilosa Retz., obs Bot. 6: 22, 1791 (non *Digitaria pilosa* Pieri in Ionios Anthol 2: 464, 1834).

D. royleana (Nees) Prain, Beng. Pl. 1181, 1903; Cooke, 2: 942 (3: 459); Blatter & McCann, 127, t. 82.

Paspalum royleana Nees ex Thum. Enum. Pl. Zeyl. 358, 1864. (non. nud) ex Hook. f., in Fl. Brit. India 7: 18, 1869.

Quite common grass in moist places and along water course.

FLOWERS: November-December.

4. **Digitaria ternata** (A. Rich.) Stapf ex Dyer, Fl. Cap. 7: 376, 1898; Cooke, 2: 940 (3: 457); Bor, 306.

Cynodon ternatus A. Rich. Tent. Fl. Abyse. 2: 405, 1851.

A rare species near Lingmala.

FLOWERS: September.

Dimeria R. Br.

1. Spikelets 1.5-2.5 mm. long; anthers 0.5 mm. long .... *D. ornithopoda*
1. Spikelets 2.5-3 mm long; anthers 1.5 mm long .... *D. ornithopoda* var. *megalentha*

1. **Dimeria ornithopoda** Trin., Fund. Agrost. 167, t. 14, 1820; Cooke 2: 945 (3: 462); Blatter & McCann, 8, t. 4; Puri & Mahajan, 135; Bor 144.

D. filiformis (Roxb.) Hochst. ex Miq. in Verh. Noderl Inst. 3(4): 35, 1851.

Andropogon filiformis Roxb. Fl. Ind. 1: 260, 1820 (non Pers. 1805).

Psilostachys filiformis Dalz. et Gibs. Bombay Fl. 305, 1861.

Common grass in drying rice-fields. Dr. Bor (l.c.) has interchanged the distribution of var. *khasiana* and the typical variety.

FLOWERS: October-December.

2. **Dimeria ornithopoda** var. **megalentha** Bor, in Kew Bull. 1952: 576, 1952; Bor, 144.

D. ornithopoda var. *tenera* Birdwood, Cat. Pl. Matheran and Mahabaleshwar, 30, 1897 (nomen).

Common grass in drying rice-fields and in partially wet ground.

FLOWERS: October-November.

Echinochloa P. Beauv.

1. **Echinochloa colonum** (Linn.) Link, Hort. Berol. 2: 209, 1833; Blatter & McCann, 148, t. 94; Bor, 308, f. 34.

Panicum colonum Linn. Syst. Nat. ed 10, 2: 870, 1759; Birdwood, 30; Cooke, 2: 931 (3: 477).

Very common and abundant species in wetlands, along margins of water-courses and in rice-fields.

FLOWERS: July-October.

VERN NAMES: Rovar, Savank, Harund.

Eleusine Gaertn.

1. **Eleusine coracana** (Linn.) Gaertn., Fruct. 1: 8, t. 1, f. 11, 1789; Graham, 235; Dalzell & Gibson, suppl. 97; Birdwood, 31; Cooke, 2: 1039 (3: 561); Blatter & McCann, 260, t. 173; Bor, 492.

Cynosurus coracana Linn. Syst. Nat. ed 10, 2: 875, 1759.

Quite commonly cultivated on sloping grounds. Very often shifting farming method is used for this species and large forest areas are destroyed for creating space for cultivation of crop.

FLOWERS: October.

VERN. NAMES: Nachni, Nagli, Ragi.

Eragrostis P. Beauv.

1. Rhachis fragile; spikelets breaking up from above downwards .... *E. ciliaris*
1. Rhachis tough; spikelets breaking up from below upwards 2
   2. Annuals .... *E. unioloides*
   2. Perennials 3
      3. Spikelets fascicled or shortly pedicellate in narrow racemes .... *E. chariis*
      3. Spikelets not fascicled; long pedicellate .. .. *E. tenuifolia*

1. **Eragrostis chariis** (Schult.) Hitch. in Lingoan Sci. J. 7: 193, 1931.

Poa chariis Schult. Mant. 2: 314, 1824.

E. gangetica Cooke, 2: 1025 (3: 547); Blatter & McCann, 236 (non Steud. 1854).

E. nutans (Retz.) Nees ex Steud., Nom. Bot. ed 2, 563, 1840; Bor, Grass. India, Burma Ceylone, 511, 1960. (non Nees ex Wight 1833); Bor, 511.

Poa nutans Retz. Obs. Bot. 4: 19, 1786.

A common species on wet ground and on margins of tanks and streams.

FLOWERS: November.

2. **Eragrostis ciliaris** (Linn.) R. Br., in Tuckey, Narr. Exp. Congo, App. 478, 1818; Cooke 2: 1022 (3: 545); Birdwood, 31; Bor, 506.

Poa ciliaris Linn. Syst. Nat. ed. 10, 2: 875, 1759.

This species is included here on the authority of Birdwood.

VERN. NAME: Undir Punjo.

3. **Eragrostis tenuifolia** Hochst. ex Steud. Syn. Pl. Glum. 1: 268, 1854; Cooke, 2: 1027 (3: 549); Bor, 514.

Poa tenuifolia A. Rich., Tent. Fl. Abyss. 2: 425, 1851.

Rare species, collected from Bhilar Estate.

FLOWERS: October.

4. **Eragrostis unioloides** (Retz.) Nees ex Steud. Syn. Pl. Glume 1: 264, 1854; Cooke, 264, 1885; Birdwood, 31; Blatter & McCann, 235, t. 156; Bor, 515.

Poa unioloides Retz. Obs. Bot. 5: 19, 1789; Graham, 230.

E. amabilis Wt. & Arn. ex Nees in Hook. & Arn. Bot. Beech Voy. 251, 1830-41; Cooke, 2: 1025 (3: 546).

Very common grass all over Mahabaleshwar.

DISTRIBUTION: Chinaman's Falls, Lodwick point, Fitzgerald Ghat, Bhilar.

FLOWERS: September-November.

Eulalia Kunth

1. **Eulalia trispicata** (Schult.) Henr. in Blumea 3: 453, 1940; Bor, 157.

Andropogon trispicatus Schult., Syst. Veg. 2: Mant. 452, 1824.

A. tristachyus Roxb. Fl. Ind. 1: 261, 1820 (non H.B.K., 1816).

E. argentea Brongn. in Duperr., Voy. Coquille Bot. 2(2): 92, 1830.

Pollinia argentea Trin. Bull. Sc. Acad. Petursb. 1: 71, 1836; Cooke, 2: 950 (3: 467).

Common grass in open grass-lands.

FLOWERS: October-December.

Garnotia Brongn.

1. **Garnotia arborum** Stapf ex Cooke, Fl. Bombay Pres. 2: 1013, 1908; Blatter & McCann, 206, t. 135; Bor, 567.

This species is found epiphytic on trees or lithophytic on rocks and also seen growing on embankments and on roof-tiles.

FLOWERS: September-October.

Hackelochloa O. Kuntze

1. **Hackelochloa granularis** (Linn.) O Kuntze, Rev. Gen. Pl. 776, 1891; Bor, 159.

Manisuris granularis Linn. f. Nov. Gram. Gen. 40, 1779; Birdwood, 30; Cooke, 2: 955 (3: 473).

Cenchrus granularis Linn. Mant. 2 (Append.): 575, 1771.

Rare species in open grass-lands.

FLOWERS: September-October.

VERN. NAME: Kanjani (Birdwood).

Heteropogon Pers.

1. Margins of the lower glume of pedicellate spikelets equally winged, the keels studded with long yellow bristles; ligule of several narrow membranous segments; annual .... *H. ritchiei*
1. Margins of the lower glume of pedicellate spikelets unequally winged, the keels not studded with bristles; ligule truncate, ciliolate; perennial .... *H. contortus*

1. **Heteropogon contortus** (Linn.) P. Beauv. ex Roem. et Schult. Syst. Veg. 2: 836, 1817; Birdwood, 30; Blatter & McCann, 109, t. 71; Bor, 163, f. 6.

Andropogon contortus Linn. Sp. Pl. 1043, 1753; Cooke, 2: 990 (3: 510).

Common grass all over in open grass-lands. The sharp twisted awns of this grass stick in the garments and sometimes in the flesh of people as well as animals causing serious trouble.

FLOWERS: September-October.

VERN. NAMES: Kusal, Pandhri Sukal.

2. **Heteropogon ritchiei** (Hook. f.) Blatter & McCann, in Journ. Bombay nat. Hist. Soc. 32: 623, 1928 & Bombay Grass, 108, t. 70; Bor, 165.

Andropogon ritchiei Hook. f., in Fl. Brit. India, 7: 201, 1896; Cooke, 2: 990 (3: 509).

Rare grass in grass-lands.

FLOWERS: October.

Hordeum Linn.

1. **Hordeum hexastichon** Linn. Sp. Pl. 85, 1753; Graham, 234; Dalz. & Gibs. suppl. 96.

H. vulgare var. *hexastichon* Aitch. Cat. Pb. & Sind, Pl. 171, 1869; Cooke, 2: 1052 (3: 575).

Rarely cultivated in fields for grains.

LOCAL NAME: Satu, Jau.

Indochloa Bor

1. Culms glabrous below the inflorescence; pedicelled and neuter spikelets reddish-brown when dry .... *I. clarkei*
1. Culms pilose below the inflorescence; pedicelled and neuter spikelets usually greenish .... *I. oligantha*

1. **Indochloa clarkei** (Hack.) Bor, in Kew Bull. 1954; 76, 1954 & 171; Hemadri, in Indian Forester, 94: 811, 1968.

Andropogon clarkei Hack. in Ost. Bot. z 41, 49, 1891.

Rare grass along Fitzgerald ghat and on Lingmala Plateau.

FLOWERS: October.

2. **Indochloa oligantha** (Hochst.) Bor, in Kew Bull. 1954; 79, 1954 & 171.

Andropogon oliganthus Hochst. ex Steud., Syn. Pl. Glume 1: 368, 1854.

Heteropogon oliganthus (Hochst.) Blatter & McCann, in J. Bombay nat. Hist. Soc. 32: 623, 1928.

Rare, very aromatic grass on Lodwick point. Scent of the plant is due to very volatile component of the constituents of the plant because the dry herbarium specimens are completely odourless.

FLOWERS: October.

Isachne R. Br.

1. Spikelets less than 1.5 mm long ...... *I. gracilis*
1. Spikelets more than 1.5 mm long 2
 2. Florets equal in size and of same texture ... 3
  3. Glumes setosely hirsute all over .... *I. lisboae*
  3. Glumes glabrous, at least in lower half .. 4
   4. Plants erect; culms slender; florets hemispherical .... *I. elegans*
   4. Plants wiry climbers; culms woody; florets barge shaped ..... *I. anglandei*
 2. Florets unequal in size and of different texture 5
  5. Lower and upper lemmas obtuse 6
   6. Panicle lax .... *I. globosa*
   6. Panicles dense .... *I. dispar*
  5. Lower and upper lemmas apiculate or at least acute .... *I. miliacea*

1. **Isachne anglandei** C.E.C. Fisher, in Kew Bull. 1932: 323, 1932; Bor, 579.

Rare grass on moist ground.

FLOWERS: November.

2. **Isachne dispar** Trin., Sp. Gram. 1: t. 86, 1828; Bor, 580.

Rare, but gregarious species found in swampy places.

FLOWERS: September-October.

3. **Isachne elegans** Dalzell, in Dalz. & Gibs. Bombay Fl. 291, 1861; Cooke, 2: 923 (3: 439); Blatter & McCann, 187, t. 121; Bor, 580.

Quite common grass in wet rice-fields and along the margins of water-courses. According to Dr. Bor, Woodrow's specimens quoted as this species belong to *I. globosa* and *I. miliacea.*

FLOWERS: September.

VERN. NAME: Dunda.

4. **Isachne globosa** (Thunb.) O. Ktze., Rev. Gen. Pl. 2: 778, 1891; Bor, 580.

Milium globosum Thunb. Fl. Jap. 49, 1784.

I. australis R. Br. Prodr. 196, 1810; Cooke, 2: 923 (3: 439); Puri & Mahajan, 135.

Common and abundant grass in rice-fields and along water-courses. It is a troublesome weed in rice-fields.

FLOWERS: October.

VERN. NAME: Daura.

5. **Isachne gracilis** C. E. Hubbard, in Kew Bull. 1927: 77, 1927; Bor, 581.

Rare species along forest margins with thin membranaceous leaves growing in shady places.

FLOWERS: October-December.

6. **Isachne lisboae** Hook. f., in Fl. Brit. India, 7: 22, 1896; Birdwood, 30; Cooke, 2: 922 (3: 438); Blatter & McCann, 187; Puri & Mahajan, 135; Bor, 581.

Common stoloniferous grass in swampy places and along water-courses.

DISTRIBUTION: Wilson point, Lodwick point, Lingmala, Yenna lake.

FLOWERS: September-October.

7. **Isachne miliacea** Roth, Nov. Pl. Sp. 58, 1821; Cooke, 2: 923 (3: 439); Bor, 382.

Common along water courses and in stagnant swampy places.

FLOWERS: October.

Ischaemum Linn.

1. Margins of the lower glume of the sessile spikelets expanded below the middle 2

2. Keel of the upper glume of the sessile spikelet winged above the middle .... *I. indicum*
2. Keel of the upper glume of sessile spikelet not winged above the middle .... *I. timorense*

1. Margins of the lower glume of sessile spikelets narrowly and evenly inturned from base to apex 3
   3. Base of the lower leaves acute, rounded or shallowly cordate, without a petiole 4
      4. Pedicel of the pedicelled spikelet more than one third the length of the sessile spikelet .... *I. diplopogon*
      4. Pedicel of the pedicelled spikelet less than one-third of the length of the sessile spikelet .... *I. imbricatum*
   3. Base of the lower leaves sagittate or deeply cordate, with distinct petiole 5
      5. Pedicels of the pedicelled spikelets longer than one third of the length of the sessile spikelets .... *I. impressum*
      5. Pedicels of the pedicelled spikelets less than one-third of the sessile spikelets .... *I. semisagittatum*

1. **Ischaemum diplopogon** Hook. f., Fl. Brit. India, 7: 129, 1896; Cooke, 2: 960 (3: 478); Blatter & McCann 14, t. 8; Puri & Mahajan, 135; Bor, 178.

Common and abundant grass along water-courses, especially near water-falls, growing on wet rocks.

DISTRIBUTION: Fitzgerald Ghat, Bhilar.

FLOWERS: October-December.

2. **Ischaemum impressum** Hack., in DC. Monogr. 6: 210, 1889; Blatter & McCann 17; Puri & Mahajan, 135; Bor, 180.

Quite comon grass in open grass-lands and along the forest paths.

DISTRIBUTION: Bhilar, Dhobi's falls, Wilson point.

FLOWERS: September-November.

3. **Ischaemum imbricatum** (Hack.) Stapf, ex Ridley, Fl. Malay Pen. 5: 200, 1925.

I. goebelii Hack. in Ost. Bot. z. 51: 149, 1901; Bor, 179.

Meoschicon imbricatum Munro ex Hack. DC., Monogr. Phan. 6: 203, 1889.

Rare grass at Mahabaleshwar. Only known from a single collection (W. A. Talbot — 4534).

FLOWERS: October.

4. **Ischaemum indicum** (Houtt.) Merrill, in J. Arb. Arbor. 19: 320, 1930; Bor, 180.

Phleum indicum Houtt. Nat. Hist. II, 13: 198, t. 90, f. 2, 1782.

I. aristatum auct. (non Linn. 1753); Cooke, Fl. Bombay Press. 2: 958, 1908.

Common and abundant grass all over in open grass-lands.

FLOWERS: September-November.

5. **Ischaemum semisagittatum** Roxb. Fl. Ind. 1: 322, 1820; Cooke, 2: 961 (3: 479); Blatter & McCann, 15; Bor, 185.

I. cenjugatum Roxb. Fl. Ind. 1: 323, 1820; Birdwood, 30.

Common and abundant gregarious grass generally found in shady places.

FLOWERS: November.

6. **Ischaemum timorense** Kunth. Rev. Gram. 1: 369, t. 98, 1830; Blatter & McCann, 19; Bor, 185.

A common grass generally found in shades of small bushy shrubs. It assumes scandent habit and flowering spikes protrude above the host plant.

FLOWERS: October-November.

Iseilema Anders.

1. **Iseilema laxum** Hack., in DC. Monogr. Phan. 6: 682, 1889; Blatter & McCann, 113; Bor, 188.

Quite common scandent grass in shady places.

FLOWERS: November.

Jansenella Bor

1. **Jansenella griffithiana** (C. Muell.) Bor, in Kew Bull. 1955: 98, 195; Bor, 426.

Dantheonia griffithiana C. Muell. in Bot. Z. 14: 347, 1856.

Arundinella avenacea Munro ex Thw., Enum. Pl. Zeyl. 362, 1864; Birdwood, 30; Cooke, 2: 1000 (3: 520); Blatter & McCann, 191, t. 124; Puri & Mahajan, 136.

A. campbelliana Lisboa in J. Bombay nat. Hist. Soc. 5: 346, 1891.

A common grass in moist places as well as in rocky situations all over Mahabaleshwar. Also found in open grasslands.

DISTRIBUTION: Dhobi's falls, Chinaman's falls, Petite Road, Lodwick point and Bhilar.

Manisuris L.

1. Lower glume of sessile spikelet not awned .... *M. clarkei*
1. Lower glume of sessile spikelet awned 2
   2. Awns long; lower glume decorated with transverse rows of exaggerated tubercles or hooks, the latter sometimes bearded at the tips .... *M. forficulata*
   2. Awns short, not much longer than the wings; surface of the lower glume without tubercles or hooks, softly hirsute with white hairs .... *M. forficulata* var. *hirsuta*

1. **Manisuris clarkei** (Hack.) Bor apud Santapau in Rec. Bot. Surv. Ind. 16(1): 357, 1953; Fl. Khandala (ed. 3) 316, 1967.

Rottboellia clarkei Hack. in Oest. Bot. Z. 41: 8, 1891; FBI 7: 156; Cooke, 2: 954 (3: 472).

Coelorhachis clarkei Blatt. & McCann in Journ. Bombay nat. Hist. Soc. 32: 33, 1927 & Bombay Grass. 41, t. 29.

Rare grass in open grass-lands.

FLOWERS: October.

2. **Manisuris forficulata** Fisher in Kew Bull. 1933: 355, 1933; Bor 192; Santapau, Fl. Khand. (ed. 3) 316, 1967.

Glyphochloa forficulata (Fisher) Clayton in Kew Bull. 35(4): 815, 1981.

Rottboellia divergens Lisboa, Bombay Grass. 57, 1896; Birdwood, 30; Cooke. 2: 952 (3: 470) (non Hack. 1889).

Peltophorus divergens Blatter & McCann, Grass. 34, t. 23, 1935 (non A. Camus, 1921); Puri & Mahajan 30.

Common and abundant grass in open grasslands, especially in hard rocky grounds.

DISTRIBUTION: Lodwick point, Wilson point.

FLOWERS: October.

3. **Manisuris forficulata** var. **hirsuta** C.E.C. Fisher, in Kew Bull. 1933: 357, 1933; Bor, 192.

There is only one specimen of this variety in Blatter Herbarium from Mahabaleshwar. The specimen is mounted on same sheet as that *M. forficulata* and has same external appearance. But on close examination it was found that it is not the typical variety. Dr. S. K. Jain has transferred var. *hirsuta* C.E.C. Fisher to *M. divergens* Hack. we feel sure on the bases of the above mentioned specimen that the variety is more allied to *M. forficulata* Fisher than *M. divergens* Hack.

Ophiurus Gaertn. f.

1. **Ophiurus corymbosus** Gaertn. f., Fruct. 3: 4, t. 181, 1805; Birdwood, 30; Cooke 2: 951 (3: 468).

Rottboellia exaltata (auct. non Linn. f.) Bor, Grasses Burma, Ceylon, India and Pakistan, 206, 1960.

This species is reported by Birdwood from Mahabaleshwar.

Oplismenus P. Beauv.

1. **Oplismenus compositus** (Linn.) P. Beauv., Ess. Agrest. 54 168-9, 1812; Birdwood, 30; Cooke, 2: 917 (3: 442); Blatter & McCann, 152, t. 96; Bor, 317.

Panicum compositus Linn. Sp. Pl. 57, 1753.

Common and gregarious among the undergrowths along the margins of the forests as well as in deeply shaded forests.

DISTRIBUTION: Fitzgerald Ghat.

FLOWERS: October.

Oryza Linn.

1. **Oryza sativa** Linn. Sp. Pl. 333, 1753; Bird-

wood, 30; Cooke, 2: 1043 (3: 565); Santapau, 312, 1953; Bor, 605.

Oryza rufipogon Griff, Netul. 3: 5, 1851; Bor, 605.

Quite common near rice-fields in abandoned plots and on sides of marshy land. Cultivated rice crop or paddy. Major food of inhabitants of Mahabaleshwar.

FLOWERS: August-September.

Oxytenanthera Munro

1. Spikelets 1-flowered .... *O. ritcheyi*
1. Spikelets 2-flowered .... *O. stocksii*

1. **Oxytenanthera ritcheyi** (Munro) Blatter & McCann in Journ. Bombay nat. Hist. Soc. 33: 773, 1929 & Bombay grasses, 284.

Bambusa ritcheyi Munro, in Trans. Linn. Soc. 26: 113, 1868.

Oxytenathera monostigma Bedd. For. Man. in For. Sylvat. 233, 1873, et Icon Pl. Ind. Or. 56, t. 234, 1874; Cooke 2: 1048 (3: 571); Puri & Mahajan, 136.

Common small size bamboo on hill slopes along road-sides. Not seen in flower.

2. **Oxytenanthera stocksii** Munro, in Trans. Linn. Soc. 26: 130, 1868; Cooke 2: 1048 (3: 571); Birdwood, 31.

This species is included on the authority of Birdwood. We have not seen any reliable specimen of this species from Mahabaleshwar.

Panicum Linn.

1. Spikelets greenish .... *P. psilopodium*
2. Spikelets purple .... *P. psilopodium* var. *coloratum*

1. **Panicum psilopodium** Trin. Gram. Panic. 217, 1826; Blatter & McCann, 158; Bor, 329.

Common and abundant grass in wet ground and along the margins of rice-fields and along the sides of streams.

FLOWERS: September-October.

VERN. NAME: Saga.

2. **Panicum psilopodium** var. **coloratum** Hook. f., Fl. Brit. Ind. 7: 47, 1896; Bor, 330.

Quite common grass in wet places along with its typical variety.

FLOWERS: September-October.

Paspalum Linn.

1. Spikelets small, less than 1.25 mm long 2
   2. Margins of the upper glume glabrous .... *P. canarae* var. *canarae*
   2. Margins of the upper glume fimbriate .... *P. canarae* var. *fimbriatum*
1. Spikelets more than 2.5 mm long .... *P. scrobiculatum*

1. **Paspalum canarae** (Steud.) Veldkamp, Blumea 21(1): 72, 1973.

Panicum canarae Steud. Syn. Pl. gram. 1: 58, 1854.

Paspalum compactum auct (non — Roth. 1821); Cooke, 2: 943 (3: 460); Blatter & McCann, 138, t. 88; Puri & Mahajan, 135; Bor, 336.

P. costatum Hochst. in Herb. Hohenck. (nomen nudum); Birdwood, 30.

Quite common grass in wet places and near water-courses.

FLOWERS: August-September.

2. **Paspalum canarae** (Steud.) Veldkamp var. **fimbriatum** (Bor) Vedlk. in Blumea 21: 72, 1973.

P. compactum var. *fimbriatum* Bor, in Grasses Ind., Burm., Ceylon 336, 1960.

Quite frequent grass in wet places and in marshy land. It differs from the typical variety due to its hairy nature.

DISTRIBUTION: Lodwick point, Fitzgerald ghat.

FLOWERS: August-September.

3. **Paspalum scrobiculatum** Linn. Mant. Pl. 1: 29, 1767; Cooke 2: 943 (3: 460); Birdwood, 30; Bor, 340.

Rare grass found in waste-lands and in abandoned rice-fields. Very often cultivated on small scales for its grains.

FLOWERS: August-September.

Pennisetum Rich.

1. Anther-cells bearded at the apex .... *P. americanum*
1. Anther-cells not bearded at the apex .... *P. hohenackeri*

1. **Pennisetum americanum** (Linn.) K. Schum. in Engl. Planzens. Ost. Afr. B. 51, C. t. 4, A. B. 1895.

Holcus spicatus Linn. Syst. ed. 10, 1305, 1759; Graham, 238; Dalz. & Gibs. suppl. 99.

Panicum americanum Linn. Sp. Pl. 56, 1753.

P. typhoideum Rich. in Pers. Syn. 1: 72, 1805; Birdwood, 30; Cooke, 2: 917 (3: 432).

Quite commonly cultivated along with *Zea mays* Linn.

VERN. NAME: Bajri (Birdwood).

ENGLISH NAME: Pearl millet.

2. **Pennisetum hohenackeri** Hochst. ex Steud., Syn. Pl. Glum., 1; 103, 1854; Bor 344. *P. aureum* Dalz. & Gibs. Bombay Fl. 294, 1861.

P. aureum Link., Hort. Berol. 1: 215, 1827?.

P. alopecuros Steud., loc. cit. 102 (non Jacq. 1813); Cooke, 2: 414 (3: 430).

Gymnothrix cenchroides Roem. et Schultz., Syst. Veg. 2: 499, 1817 (non *Pennisetum cenchroides* Rich.)

FLOWERS: October.

VERN. NAME: Mohl.

Phalaris Linn.

1. **Phalaris minor** Retz. Obs. Bot. 3: 8, 1783; Bor 616.

There is only one specimen of this species in Blatter Herbarium which is collected from waste lands near market.

FLOWERS: March.

Pseudodichanthium Bor

1. **Pseudodichanthium cookei** (Stapf ex Cooke) Almeida comb. nov.

Pseudodichanthium serrafalcoides (Cooke at Stapf) Bor, in Ind. For. 66: 272, 1940; Bor, 204.

Andropogon serrafalcoides Cooke et Stapf., in Kew Bull. 1908: 450, 1910.

A. cookei Stapf ex Woodrow, in J. Bombay nat. Hist. Soc. 13: 438, 1898, nom nudum et Cooke, 2: 986, 1908.

Dichanthium serrafalcoides Blatter & McCann, J. Bombay nat. Hist. Soc. 32: 426, 1928; Bombay Grass, 95, t. 63.

Common grass on hill-slopes among other grasses.

FLOWERS: September-October.

Pseudosorghum A. Camus

1. **Pseudosorghum fasciculare** (Roxb.) A. Camus, in Bull. Mus. Hist. Nat. Paris 26: 662, 1920; Bor. 205.

Andropogon fascicularis Roxb. Fl. Ind. 1: 269, 1820 (non Thwaites 1864).

Rare grass at Mahabaleshwar. This is the first report of this species from Maharashtra. There is only one specimen collected from Lingmala. (P. V. Bole 370).

FLOWERS: October.

Rhynchelytrum Nees

1. **Rhynchelytrum villosum** (Parl.) Chiv. in Ann. 1st Bot. Roma 8: 310, 1908; Bor, 355.

Monochyron villosum Parl. in Hook., Niger Fl. 191, 1849.

Tricholaena wightii Arn. et Nees, in Linnaea 16: 218, 1842 (nomen nudum); Birdwood, 30; Cooke, 2: 925 (3: 441); Blatter & McCann 176-7, t. 112.

This species is included here on the authority of Puri & Mahajan. We have not seen any specimen from Mahabaleshwar.

FLOWERS: September.

VERN. NAME: Chota Kagli.

Saccharum Linn.

1. **Saccharum officinarum** Linn. Sp. Pl. 54,

1753; Cooke 2: 948 (3: 466); Birdwood, 30; Bor, 212.

Very rare in cultivation at Mahabaleshwar on sides of Yenna river.

LOCAL NAME: Uns.

ENGLISH NAME: Sugar-cane.

Sacciolepis Nash.

1. **Sacciolepis indica** (Linn.) A. Chase, in Proc. Biol. Soc. Wash. 21: 8, 1908; Bor, 357.

Aira spicata Linn. Sp. Pl. 1: 63, 1753.

A. indica Linn. Sp. Pl. Errata, 1753 (Linnaeus changed original name because of other.

A. spicata on page 64 of Species Plantarum.

Quite common weed in rice-fields and in wet places.

FLOWERS: October.

Sehima Forsk.

1. **Sehima nervosum** (Rottl.) Stapf, in Prain Fl. Trop. Africa, 9: 36, 1917; Blatter & McCann, 21, t. 14; Bor, 218.

Andropogon nervosum Rottl. Apud. Willd. in Verh. Ges. Naturf. Freund. Berlin, Newe Schr. 4: 218, 1806.

Ischaemum laxum R. Br. Prodr. 205, 1810; Birdwood, 30; Cooke, 2: 964 (3: 482).

This grass is included here on the authority of Birdwood, who reports it from Mahabaleshwar.

Setaria P. Beauv.

1. Inflorescence a cylindric and dense or sometimes lobed spiciform panicle; lobes folded or flat 2
    2. Upper glume as long as upper lemma; upper lemma smooth or minutely rugulose .... *S. italica*
    2. Upper glume shorter than upper lemma; upper lemma rugose 3
        3. Upper lemma coarsely rugose, slightly keeled upwards .... *S. glauca*
        3. Upper lemma finely rugose, not keeled .. .. *S. pallide-fusca*
1. Inflorescence dense or rather loose, narrow or widely spreading panicle; leaves folded in fan-fashion between the longitudinal nerves .... *S. plicata*

1. **Setaria glauca** (Linn.) P. Beauv. Ess. Agrost. 51: 169, 178, 1812; Dalz. & Gibs. 293; Cooke, 652, 1885 & 920 (3: 435); Birdwood, 30; Puri & Mahajan, 134; Bor, 360.

Panicum glaucum Linn. Sp. Pl. 56, 1753.

Rare grass at Mahabaleshwar. Very often confused with *S. pallide-fusca* (Schumch.) Stapf, but could be separated easily due to its coarsely rugose upper lemma.

FLOWERS: October.

VERN. NAME: Kolara.

2. **Setaria italica** (Linn.) P. Beauv., Ess. Agrost. 51: 170, 178, 1812; Cooke, 2: 921 (3: 437); Birdwood, 30; Bor, 362.

Panicum italicum Linn. Sp. Pl. 56, 1753; Graham, 237; Dalz. & Gibs. suppl. 98.

Widely cultivated species of millet. Generally grown on hard forest lands which are cleared for the purpose of cultivation just before the monsoon.

VERN. NAME: Rala.

3. **Setaria pallide-fusca** (Schumach.) Stapf et C. E. Hubb., in Kew Bull. 1930: 259, 1930. Bor, 363.

Panicum pallide-fuscum Schmach., Besker. Guin Pl. 58, 1827.

Common grass in open grasslands. Most of the specimen of this species in Blatter Herbarium were identified as *S. glauca* (L.) P. Beau. which have been corrected by N. L. Bor.

FLOWERS: September.

4. **Setaria plicata** (Lamk.) T. Cooke, Fl. Bombay Pres. 2: 919, 1908 & Reprint (3: 434); Bor, 364.

Panicum plicataum Lamk. Encycl. Meth. Bot. 4: 736, 1797.

Rare grass at Mahabaleshwar.

FLOWERS: November.

Spodiopogon Trin.

1. **Spodiopogon rhizophorus** (Steud.) Pilger, in Engler & Prantl, Naturl. Pflanzenf. Aufl. 2, 14e: 119, 1940.

Andropogon rhizophorus Steud. Syn. Pl. Glum. 1: 381, 1855.

S. albidus Benth. in J. Linn. Soc. (Bot.) 19: 66, 1881; Cooke, 2: 947 (3: 464); Blatter & McCann, 51, t. 34; Puri & Mahajan, 135.

Quite common grass along margins of forests and along road-side in partially shaded places. It is very prominent grass due to its long petiole, and hanging leaf-blades.

DISTRIBUTION: Pratapsingh Garden, Dhobi's falls, Lingmala, Fitzgerald Ghat.

FLOWERS: September-October.

Themeda Forsk.

1. Pairs of the involucral spikelets inserted at different levels 2
   2. Racemes less than 1.5 cm long .... *T. triandra* (p.p.)
   2. Racemes much longer than 1.5 cm .... *T. tremula*
1. Pairs of the involucral spikelets inserted at the same level 3
   3. Involucral spikelets over 6 mm long; awns upto 6 cm long .... *T. triandra* (p.p.)
   3. Involucral spikelets less than 6 mm long; awns less than 6 cm long .... *T. quadrivalvis*

1. **Themeda quadrivalvis** (Linn.) O. K., Rev. Gen. Pl. 2: 794, 1891; Puri & Mahajan, 136; Bor, 252.

Anthistiria ciliata Linn. f. suppl. 113, 1781; Birdwood, 30; Cooke, 2: 994 (3: 564).

Quite robust grass, common in open grasslands. Very favourite grass of grazing animals when young.

DISTRIBUTION: Bhilar, Lodwick point.

FLOWERS: October-November.

2. **Themeda tremula** (Nees ex Steud.) Hack., DC. Monogr. Phan. 6: 667, 1889; Cooke 2: 995 (3: 515); Blatter & McCann, 119, t. 75; Bor, 254.

Anthistiria tremula Nees ex Steud. Syn. Pl. Glum. 1: 401, 1855.

Common and abundant grass in open Grasslands. Favourite grass of cattle.

FLOWERS: October-November.

3. **Themeda triandra** Fosk., Fl. Aegypt.-Arb. 123, 178, 1775; Blatter & McCann, 115, t. 74; Bor, 254.

Anthistiria ciliata Nees in Linnaea, 7: 284, 1832 (non Linn. f. 17); Graham, 239; Dalz. & Gibs. 304.

A. imberbis Retz. Obs. 3: 11, 1783.

T. imberbis (Retz.) Cooke, Fl. Bombay Pres. 2: 993, 1908 & Reprint (3: 513).

Common and abundant grass in open grasslands one of the favourite grasses of grazing cattle.

FLOWERS: October-December.

Thysanolaena Nees

1. **Thysanolaena maxima** (Roxb.) O. Kuntze, Rev. Gen. Pl. 2: 794, 1891; Bor, 650.

Agrostis maxima Roxb. Fl. Ind. 1: 319, 1820.

T. agrostis Nees, in Edinb. New Phil. J. 18: 180, 1835; Cooke 2: 1006 (3: 527).

A rare grass usually found near the vicinity of water.

FLOWERS: January-February.

LOCAL NAME: Barucha.

Triticum Linn.

1. Spikelets tomentose .... *T. pilosum*
1. Spikelets glabrous .... *T. aestivum*

1. **Triticum aestivum** Linn. Sp. Pl. 1: 85, 1753; Graham, 234; Dalz. & Gibs. suppl. 97; Bor, 679.

T. vulgare Lamk. Fl. Franc 3: 153, 1778; Vill. Hist. Pl. Dauph. 2: 153, 1787; Birdwood, 31.

Rare species in cultivation.

LOCAL NAME: Gahu.

ENGLISH NAME: Wheat.

2. **Triticum pilosum** Dalz. & Gibs. Bombay Fl. suppl. 97, 1861; Woodrow, in Journ. Bombay nat. Hist. Soc. 13: 441, 1901.

T. sativum Lam. var. *pilosum* Cooke Fl. Pres. Bombay 2: 1052 (3: 575), 1906.

Rarely cultivated for its grains.

LOCAL NAMES: Bakshi, Kala-Kusli.

Trilobachne Schenck

1. **Trilobachne cookei** (Stapf) Schenck ex Henrard, in Meded. Rij. Herb. No. 67, 4, 1931; Bor, 268.

Polytoca cookei Stapf, in Hook., Ic. Pl. t. 2333, 1894. Birdwood, 30; Cooke, 2: 998 (3: 518); Blatter & McCann, 5, t. 2.

Grows sporadically in grass-lands.

FLOWERS: September-October.

Tripogon Roem et Schultz.

1. Lemmas cleft at the apex into two lobes, awned in the cleft 2
    2. Median awn as long as or longer than lemma .... *T. pauperculus*
    2. Median awn shorter than lemma or absent .. 3
        3. Leaves and culms glaucous; leaves 5-20 cm long ligule present .... *T. jaquemontii*
        3. Leaves and culms green, not glaucous; leaves 30-60 cm long; ligule absolute .... *T. lisboae*
1. Lemmas cleft at the apex into 4 lobes or with definite lobe between each lateral awn and the median .... *T. bromoides*

1. **Tripogon bromoides** (Roem. et Schult.) Roth. Nov. Sp. 49, 1821; Bor, 519.

Trianthera bromoides Roem. et Schult., Syst. Veg. 2: 600, 1817.

Common grass on rock faces in ghat areas along road-sides. Rejuvenating perennial grass which dries after the monsoon and re-appears in leaves in the next monsoon.

FLOWERS: September-November.

2. **Tripogon jacquemontii** Stapf, in Kew Bull. 1892: 85, 1892; Cooke, 2: 1037 (3: 559); Blatter & McCann, 269, t. 181; Bor, 522.

Common and abundant gregarious rejuvenating grass on rock-faces in ghat areas. It is an erect grass in monsoon but hang down after monsoon is over.

FLOWERS: October-November.

3. **Tripogon lisboae** Stapf, in Kew Bull. 1892: 84, 1892; Birdwood, 30; Cooke, 2: 1036 (3: 558); Blatter & McCann, 262, t. 180; Bor, 522.

Quite common rejuvenating grass in ghat area.

FLOWERS: October-November.

4. **Tripogon pauperculus** Stapf, in Hook. l.c. Pl. t. 2442, 1896; Cooke, 2: 1036 (3: 558); Blatter & McCann, 266, t. 178; Bor, 522.

Indopoa paupercula (Stapf), Bor, Kew Bull. 1958: 255, 1958.

Common and abundant grass found on hard rocky grounds and epiphytic on tree-trunks. N. L. Bor had separated it as belonging to a distinct genus, but later in his monograph on Asiatic grasses again assigned it to the old genus *Tripogon*.

FLOWERS: October-November.

Vetiveria Lem.-Lisanc.

1. **Vetiveria zizanioides** (Linn.) Nash., in Small, Fl. South East U.S. 67, 1903.

Phalaris zizanoides Linn. Mant. Pl. 2: 183, 1771.

Andropogon squarrosus Linn. f. suppl. 433; 1781; Cooke 2: 991 (3: 511).

A. muricatus Retz. Obs. Bot. 3: 43, 1783; Birdwood, 30.

Rare grass found on bunds and margins of rice-field in large clumps. Roots of this grass have pleasant aroma and wet roots are hung in houses for producing fragrance in summer.

FLOWERS: September-October.

Zea Linn.

1. **Zea mays** Linn. Sp. Pl. 971, 1753; Birdwood, 30; Cooke 2: 991 (3: 574).

Very common in cultivation at Mahabaleshwar. Cobs of various horticultural varieties are sold to tourists near Yenna Lake, after frying and applying salt, chili.and pepper powders.

LOCAL NAMES: Maka, Bhutta.

(*to be continued*)

NEW DESCRIPTIONS

A NEW GENUS AND SPECIES OF PYRAUSTINAE (PYRALIDAE: LEPIDOPTERA) FROM INDIA[1]

H. S. Rose and Jagbir Singh Kirti[2]

(*With five text-figures*)

A new species *banderdewaensis* referable to the genus *Arunamalaia* gen. nov. is reported from North-East India. The new genus is closely related to *Anamalaia* Munroe and Mutuura, known from South India.

Introduction

During the surveys undertaken for the collection of Pyraustin moths from various states of India, a sample of nineteen conspecific individuals was collected from Banderdewa (Arunachal Pradesh). Neither the specific status of this phenon tallied with known species nor it could be referred to any of the known Pyraustin genera. Infact, owing to the unique structures of the species, it requires a new genus for its correct placement. Accordingly, the genus *Arunamalaia* gen. nov. is proposed for this new species, named after its locality as *banderdewaensis.*

Observations

Genus **Arunamalaia** gen. nov.
(Gender: feminine)

Type-species: *Arunamalaia banderdewaensis* sp. nov.

DIAGNOSIS:

Labial palpus porrect and straight, triangularly scaled, exceeding head by twice the length of latter; third segment hidden, with a sharp triangular tuft in front. Maxillary palpus prominent, dilated with scales at extremity. Frons flat and oblique, smoothly scaled. Antenna simple, minutely ciliated in male. Fore wing with costal margin lobed behind middle in male, simple in female; termen oblique; vein R_1 arising from before anterior angle of cell; R_2 apposed to R_3+_4; stalk of R_3+_4 less than one-third length of free parts of R_3 and R_4; R_5 thick, down-curved in male due to costal lobe originating from middle of discocellulars, normal in female, M_1 from below R_5 and parallel to the latter; 3A not making anal loop; veins M_2, M_3 and Cu_1 arising from posterior angle of cell; Cu_2 from cell behind two thirds. Hind wing with veins Rs and $SC+R_1$ anastomosing behind cell; Rs and M_1 shortly stalked; M_2 and M_3 approximated for some distance; Cu_1 from well below M_3; Cu_2 from cell behind two thirds. Metathoracic tibia with outer spur of both pairs minute in male.

Male genitalia: Uncus triangular, rounded at tip; setose with anteriorly directed setae on lateral margins; gnathos absent; tuba analis longer than uncus; subscaphium strongly sclerotized; tegumen broad at base, narrow towards uncus; vinculum long, highly developed; saccus short. Valva of equal width throughout; costa narrow; sacculus with a triangular setose lobe, partly covering basal lobe of harpe; harpe with an oblique heavily setose lobe with three scale like setae dorsally and with distal

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ventrally directed claw-like process, latter having denticulate dorsal margin. Transtilla short and flap-like; juxta strongly sclerotized and bifurcated basally. Aedeagus rounded at tip, with both of its walls equally sclerotized; vesica with densely packed spine-like cornuti.

Female genitalia: Corpus bursae globular, well sclerotized; signum conspicuous, marked by a pair of quadrate and semi circular signa; an accessory sac opens in corpus bursae; ductus bursae moderately long, membranous for most of its length but strongly sclerotized, with colliculum at distal end; ostium bursae surrounded by a well sclerotized genital plate; anterior apophyses long, with triangular expansions near bases; posterior apophyses short but well sclerotized; ovipositor lobes short, setose with dense arrays of setae.

Arunamalaia banderdewaensis sp. nov.

(Figs. 1, 2, 3, 4, 5,)

Head with vertex covered with pale brown scales; frons flat, dressed with pale brown scales in centre and white along margins. Antenna shorter than fore wing, annulated with brown scales. Eye brownish-black, with a row of light yellow scales behind. Labial palpus with first segment white, second and third segments clad with pale and brown scales. Maxillary palpus well developed, dilated with white scales. Proboscis short, furnished with white scales. Under surface of head pure white.

Thorax clothed with pale brown scales dorsally and white ventrally. Fore wing with costal margin slightly lobed behind middle; posterior margin straight. Ground colour brownish-grey; a large fovea on posterior margin of cell in male; fringe brownish-grey. Discal cell with posterior margin curved. Hind wing with anterior margin weakly arched;

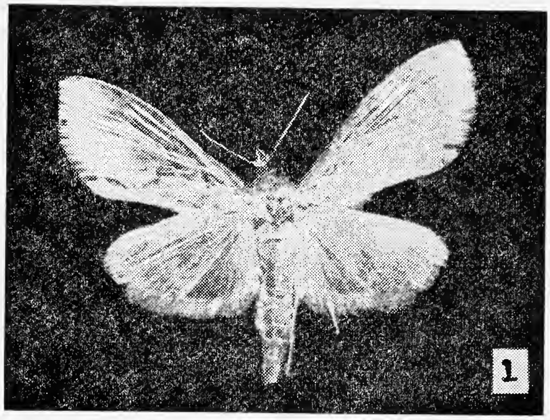


Fig. 1. *Arunamalaia banderdewaensis* sp. nov. (Adult) holotype.

apex, termen and tornus rounded. Ground colour brown, irrorated with grey and pale scales; outer margin dark grey; basal half of costa and tornus with pale scales. Discal cell less than one-third length of wing; discocellular curved inwards anteriorly, outwardly oblique posteriorly. Legs uniformly dressed with white scales; prothoracic leg with tarsi clad with greyish brown scales.

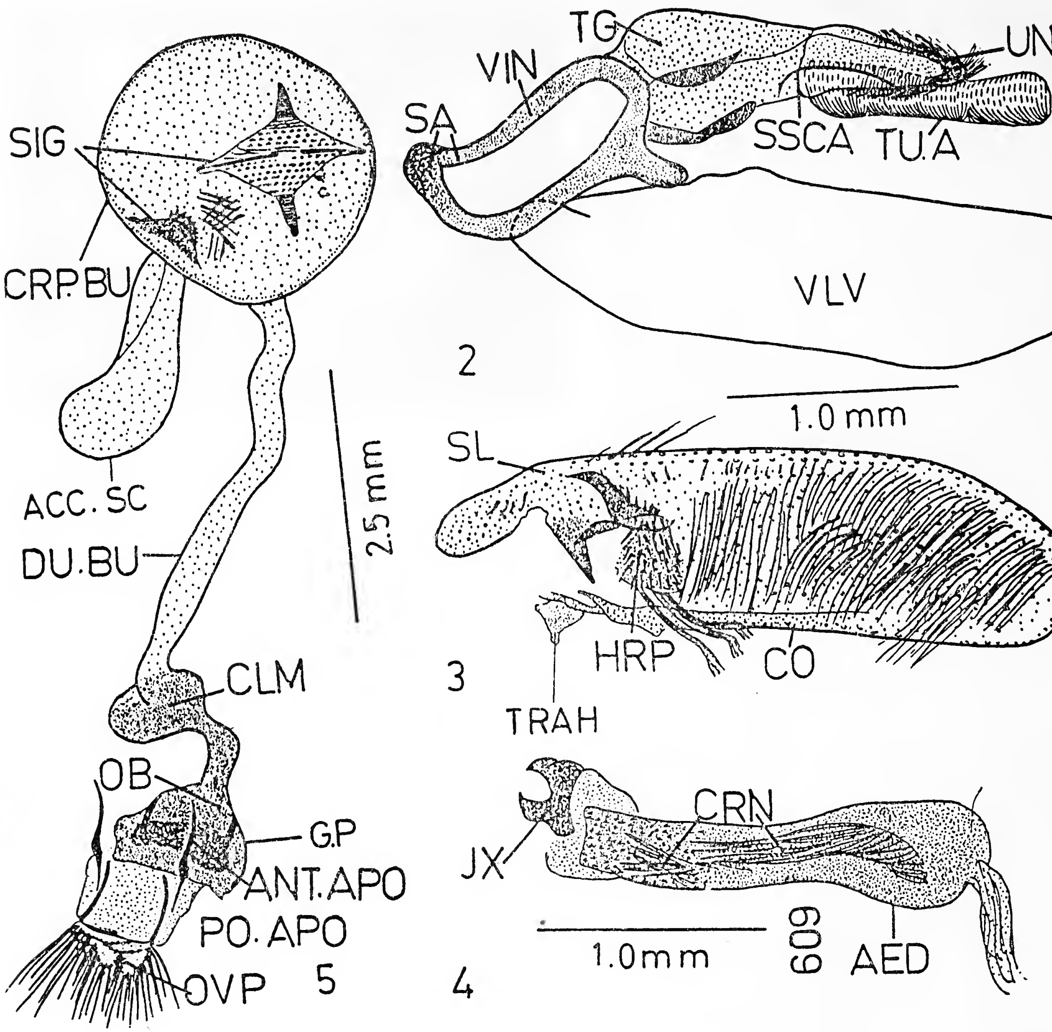
Abdomen laden with pale-brownish and white scales on dorsal side; undersurface white.

Genitalia: As described for the genus.

Wing Expanse (Half): Male : 11 mm.
Female: 12 mm.

Material Examined: Holotype: 1♂, Arunachal Pradesh: Subansiri, Bander-dewa, 1.v.82 — Allotype: ♀, same data as for holotype. Paratypes: 17 ♂♂, same locality date. 2-5.v.82.

Repository: Zoology Department Museum, Punjabi University, Patiala.



Figs. 2, 3, 4. Male genitalia of *A. banderdewaensis* sp. nov. (based on paratype).
Fig. 5. Female genitalia of *A. banderdewaensis* sp. nov. (based on allotype).

Abbreviations:

ACC. SC: Accessory Sac.; AED: Aedeagus; ANT. APO: Anterior apophyses; CLM: Colliculum; CO: Costa; CRN: Cornuti; CRP. BU: Corpus bursae; DU. BU: Ductus bursae; G.P: Genital plate; HRP: Harpe; JX: Juxta; OB: Ostium bursae; OVP: Ovipositor; PO. APO: Posterior apophyses; SA: Saccus; SIG: Signum; SL: Sacculus; SSCA: Subscaphium; TG: Tegumen; TRAH: Half Transtilla; TU.A: Tuba analis; UN: Uncus; VIN: Vinculum; VLV: Valva.

Remarks

The species *banderdewaensis* sp. nov. belongs to a group of genera, with rostriform labial palpi and dilated maxillary palpi. The venation of the wings and external genitalia of the species are quite conspicuous in many respects. The armature of the valva of the male genitalia and the ductus bursae of the female genitalia are greatly modified. These striking structures of the new species resulted in the proposing of a new genus. The genus is known by its type-species only.

The genus *Arunamalaia* is somewhat allied to *Anamalaia* Munroe and Mutuura which has been reported from Anamalai hills in south India by Munroe and Mutuura (1969). In both these genera, the structure of the uncus, shape of the valva in the male genitalia and the presence of a quadrate signum in the corpus bursae of female genitalia are quite similar. However, the labial palpus, tibial spurs, wing venation, the divisions of the valva, presence of an additional accessory arc-like signum in the corpus bursae, the heavily seterolised colliculum and the genital plate are quite distinct in *Arunamalaia* and thus are drastically different from *Anamalaia.*

Etymology:

The name of the new species pertains to the locality Banderdewa from which all the individuals of the species were collected.

Acknowledgements

We are grateful to Dr. E. G. Munroe (retired) and Dr. Mutuura (Biosystematics Research Institute, Department of Agriculture, Ottawa, Canada) for making available the relevant literature for the comparison of the species.

Reference

Munroe, E. & Mutuura, A. (1969): Contributions to a study of the Pyraustinae (Lepidoptera: Pyralidae) of Temperate East Asia. VIII. *Can. Ent. 101*: 1239-1248.

A NEW SPECIES OF *LATHROMEROMYIA* OF THE SUBGENUS *LATHROMEROMINA* (HYMENOPTERA: TRICHOGRAMMATIDAE) FROM THE EGGS OF *CORYTHAUMA AYYARI* (HETEROPTERA: TINGIDAE)[1]

David Livingstone and Mohammed Yacoob[2]

(*With seven text-figures*)

The genus *Lathromeromyia* was first described by Girault (1916) and the type *L. perminuta* was recorded as the egg parasite of a sugarcane cicada. Subsequently, Doutt and Viggiani (1968), Hayat (1981) and Lin (1981), after having clarified the earlier description of the genus, confirmed the generic characters and added two more species (*L. cercopicida* (Risbec) from Camaroons and *L. dimorpha* Hayat from India). Later, Livingstone and Yacoob (1983), after having considered the

[1] Contribution No. 46 from the Division of Entomology, Bharathiar University, Coimbatore. Accepted December 1985.

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characters of the genus (namely (1) convex curvature of the marginal vein as stigmal vein, (2) apically expanded wings, (3) a well demarcated hypopygium, and (4) absence of funicle and presence of four segmented club) described a new subgenus *Lathromeromina* as having the following characters. (1) almost bare thorax without any "characteristic" trichation, (2) only one antellus to the antenna, (3) hind wings with only one row of discal ciliation, and (4) legs and wings not longer than the body length.

On the basis of these characters the fourth species namely *Lathromeromyia* (*Lathromeromina*) *tingiphaga*, Livingstone and Yacoob was added to the world list of species of *Lathromeromyia*. The present description is the second species of the subgenus *Lathromeromina*.

Type-species: *Lathromeromyia* (*Lathromeromina*) *corythaumaii* sp. nov.

Lathromeromyia (Lathromeromina) corythaumaii sp. nov.

(Figs. 1-7)

FEMALE: Small, entire length 0.46 mm; width across the thorax 0.17 mm; face, thorax and abdomen dark brown; vertex; antennae and legs pale brown; wings hyaline.

Head: Transversely elongate, subtriangular when viewed frontally, eyes sanguineous, widely separated; ocelli three, closely set; antennae more frontally inserted, very close to each other, segmental formula 1, 1, 1, 4; one ring segment, funicle absent, club four segmented; scape with radical 2.5 times longer than broad; pedicel 1.6 times longer than broad, 0.76 times as long as the scape; annellus single, closely appressed; club elongate, 3.3 times longer than its greatest width and twice as long as the scape; club with 10-15 fine bristles, each 0.3 times as long as its segment; mandibles prominently tridentate; vertex with 6 short fine bristles, outer most pair longest.

Thorax: 0.18 mm long, almost as long as the abdomen; scutellum short, transversely elongate, almost bare; forewings hyaline, broadly elongate, apically rounded; remigium almost as long as the body, expanded apically; marginal vein short and straight; stigmal vein short, clubbed, darkly pigmented; other veins such as R, RS_1, RS_2, r-m, M, Cu, Cu_2 and A prominently indicated by the arrangement of ciliation; marginal fringes short, gradually increasing in length apically, the longest being 0.4 times as long as the greatest width of the wing; remigium with regularly arranged ciliation; basal bifurcation not prominent but extending upto the level of stigmal vein; hindwings elongate, shorter than the forewings, 10.15 times longer than its greatest width; basally stalked, median single row of discal ciliation at the anterior margin; marginal fringes elongate, almost as long as those of the forewing fringes; legs long, slender; hind legs relatively longer than the preceding ones.

Abdomen: sessile, 1.2 times longer than broad; ovipositor extending slightly beyond the apex, occupying almost 2/3 the length of the abdomen; hypopygium reaching the middle of the ovipositor.

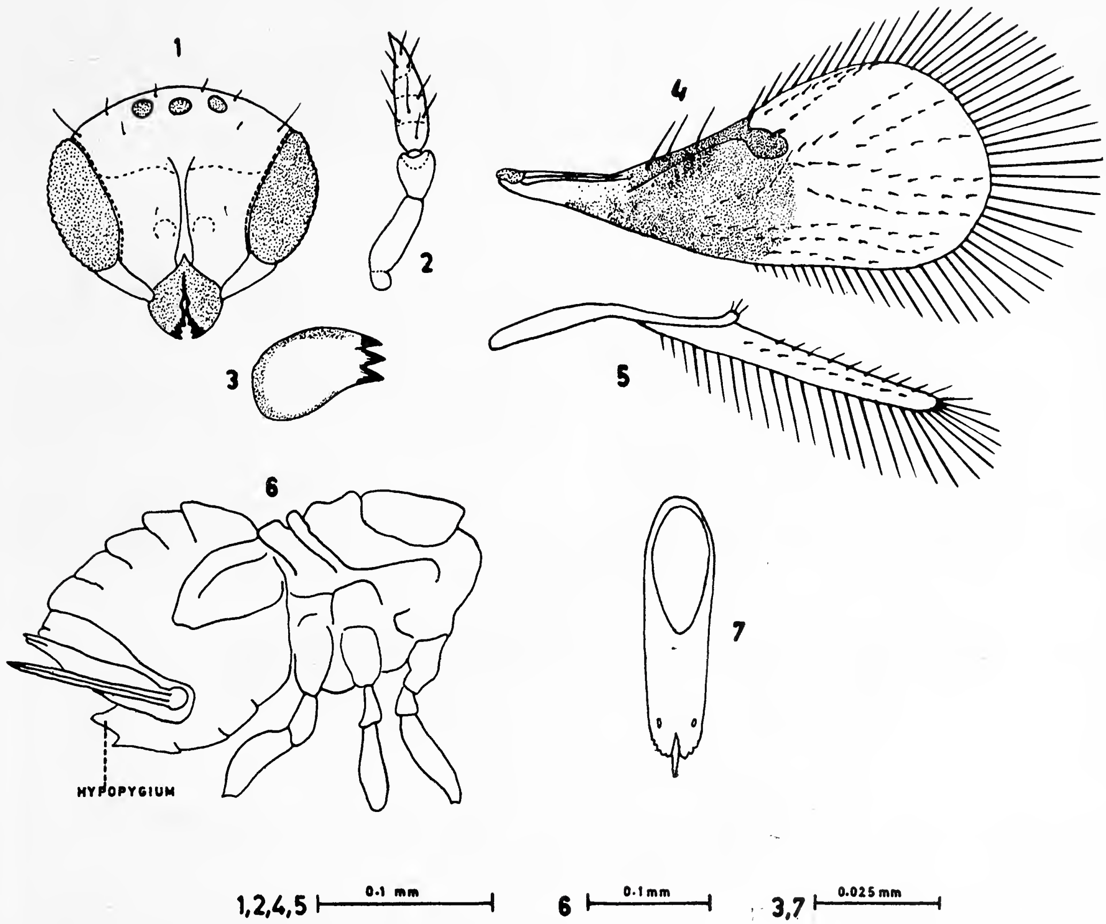
MALE: almost of the same size of the female; male genital capsule 54 micra long, 0.8 times as long as the abdomen.

Type information:

Holotype: Female, reared from the egg of *Corythauma ayyari* Drake, the jasmine tingid from Nirmala College, Coimbatore, collected on 21-1-1980.

Allotype: Male, also reared from the egg of *C. ayyari* of the same locality.

Paratypes: same data as the holotype.



Figs. 1-7. *Lathromeromyia* (*Lathromeromina*) *Corythaumaii* sp. nov.
1. Head, front view; 2. Antenna — female; 3. A mandible; 4. Forewing; 5. Hindwing; 6. Lateral view of the thorax and abdomen — female; 7. Male genital segment.

All types mounted on slides, deposited for the present in the Division of Entomology, Bharathiar University, Coimbatore, S. India.

Lathromeromyia (*Lathromeromina*) *corythaumaii* closely resembles *L.* (*L.*) *tingiphaga* in most of the morphological features. But it can be readily recognized from the latter by the shape, size (broad at the apex), definite pattern of trichatian and by the distinct tracts of R, RS_1, RS_2, r-m, M, Cu, Cu_2 and A of the forewings. The marginal fringes are distinctly shorter, the longest being not more than 0.4 times as long as the greatest width of the wings. In *L. tingiphaga* the broadest region of the remigium is only at the anterior 4/5 region, trichiation irregular, the marginal fringe almost as long as the greatest width of the wing. The hind wing of the present type species is

relatively broader, its anterior margin fringed with shorter cilia and its basal infuscation lighter when compared with that of *P. tingiphaga*. The cephalic bristles are vertical, fine and arranged in a more regular linear pattern when compared with those of *P. tingiphaga*.

ACKNOWLEDGEMENTS

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LIVINGSTONE, D. & YACOOB, M. H. S. (1983): A new subgenus of *Lathromeromyia* (Hym.: Trichogrammatidae) an egg parasite of Tingidae (Het.) from India. *Entomophaga 23*(3): 303-308.

HOMOEOGRYLLUS INDICUS SP. NOV. (ORTHOPTERA: PHALANGOPSIDAE) FROM MADHYA PRADESH, INDIA[1]

S. M. AGARWAL[2] AND K. M. SINHA[3]

(*With four text-figures*)

A new cavernicolous Orthoptera *Homoeogryllus indicus* sp. nov. (Orthoptera: Phalangopsidae) collected from Kacchuwa Pahar cave, Amadol (Botalda): Kharsia (District Raigarh), Madhya Pradesh, India, is described.

INTRODUCTION

Homoeogryllus indicus sp. nov. was collected from Kacchuwa Pahar cave, Amadol (Botalda): Kharsia (District Raigarh), Madhya Pradesh. The cave is at the peak. The interior has no stalagmite and stalactite formations but has a few small pools fed by seepage water. The ideal conditions for this species appears to be complete darkness and high humidity.

[1] Accepted November 1986.

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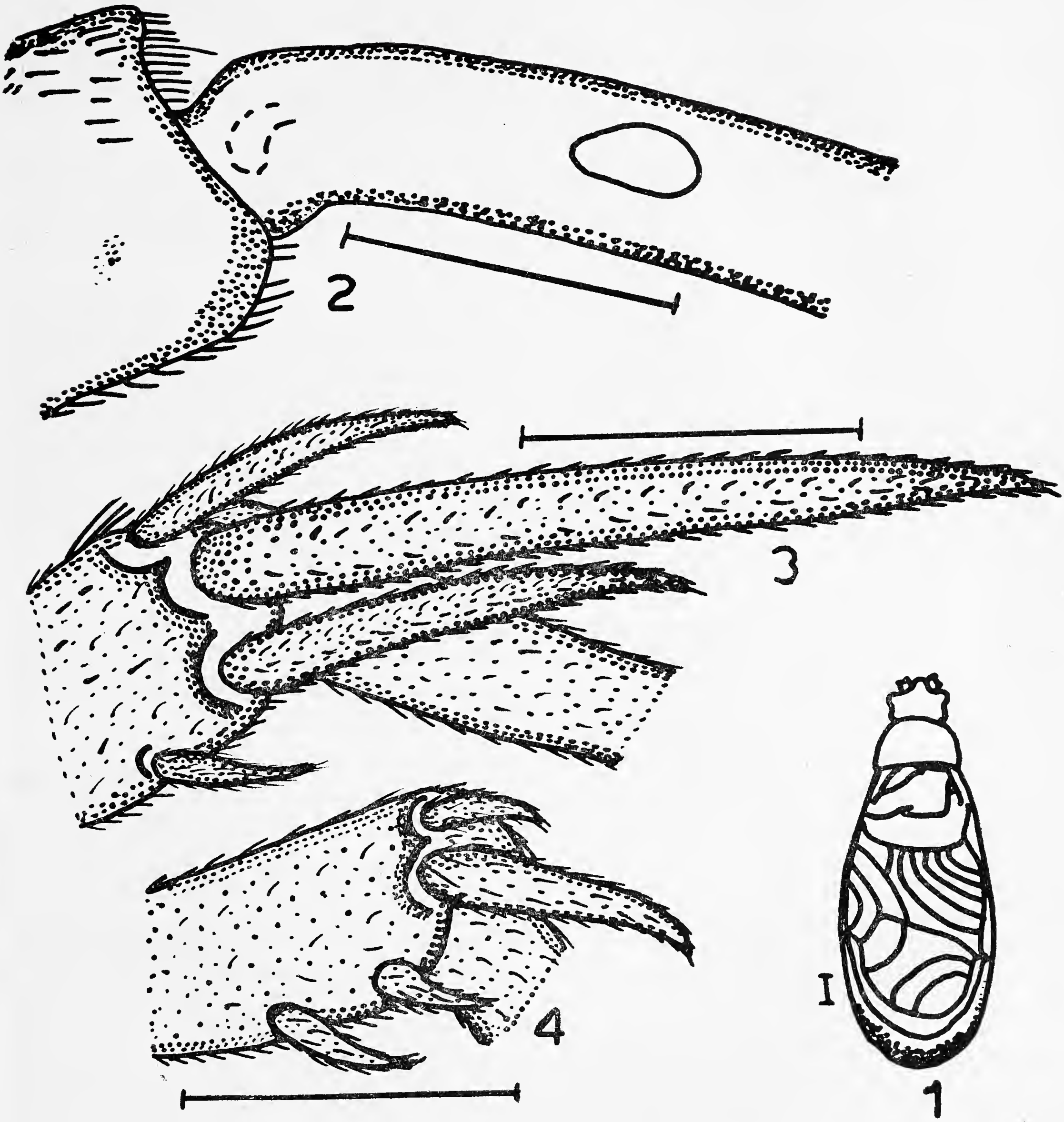
Homoeogryllus indicus sp. nov. is found on the walls. They lie hidden in groups behind projecting rocks and crevices.

KEY TO THE SPECIES OF *Homoeogryllus*

1. Antennae whitish or brownish 2
   Antennae yellowish 3
2. Antennae whitish with two first joints blackish, size smaller (length with elytra 10.5-15 mm.) .... *japonicus* (Haan)
   Antennae brownish with white ring little beyond the base, size large (length with elytra 19-24 mm.) .... *indicus* sp. nov.
3. Size rather large (length with elytra 15-18 mm.) .... *cincticornis* (Walker)
   Size smaller (length with elytra 9.5-12 mm). .... *longicornis* (Walker)



Figs. 1-4. *Homoeogryllus indicus* sp. nov., ♂
1. Body in dorsal view; 2. Proximal end of Fore tibia showing tympanum; 3. Distal end of Hind tibia (internal side); 4. Distal end of Hind tibia (external side).

Homoeogryllus indicus sp. nov.

MALE: Large sized, brown, measures 19-20 mm. Head small, frontal rostrum shorter than first joint of antennae. Antennae very large, brown with whitish ring little beyond the base. Pronotum broader than long, covered with fine hairs, its anterior border is broader than posterior, both borders straight. Mesonotum whitish, shorter than metanotum. Legs long and slender, femora and tibia brown, tarsus yellowish. Anterior legs with tympanum (Fig. 2) on both the faces with a pair of spurs at distal end. Middle legs similar to anterior ones. Posterior femora rather strong, brownish apex yellowish tibiae nearly equal to femora in length with three spines on the posterior end on both margins and six apical spurs; external spurs much shorter than internal spurs, inferior external spur very short, superior shorter than median spur (fig. 4), inferior internal spur short superior internal spur much longer, median spur longest (Fig. 3), tarsi long, metatarsus longer with two strong apical spurs, internal spur longer than external spurs. Tarsi armed with numerous bristles.

Abdominal tergites transverse, cerci long.

Elytra extending up to the end of abdomen, brown in colour, mirror prominent, divided by three curved veins, six oblique veins, subcosta with seventeen branches, apical field short. Wings absent.

Measurements: Length of body 19-20 mm, length of pronotum 3-4 mm, post-femur 15-16 mm, post-tibia 15-16 mm, cerci 19-20 mm.

FEMALE: General appearance and coloration as in male, with pair of elytra only. Abdominal tergites transverse, ovipositor long, second vulvulae small, concealed within third vulvulae, cerci long.

Measurements: Length of body 19-24 mm. length of pronotum 3-4 mm, post-femur 16-18 mm, post-tibia ,7-19 mm, cerci 22-26 mm, ovipositor 15 mm.

Homoeogryllus indicus sp. nov. differs from other known species (Chopard 1942, 1969) in the much larger size of the body; with no spots on the occiput; frontal rostrum is shorter than the first joint of the antennae, antennae very large, brown, with a whitish ring little beyond the base; both the borders of the pronotum are straight. The second pair of wings are absent.

Holotype ♂, Allotype ♀, INDIA: M.P.: Raigarh (District): Kharsia: Amadol (Botalda): Kacchuwa Pahar cave, coll. K. M. Sinha, 15.x.1978.

Paratype 1 ♂, 1 ♀, other data as for holotype.

ACKNOWLEDGEMENTS

Grateful thanks are due to Dr. Daniel Otte, Associate Curator of Entomology, Museum of Academy of Natural Science, Philadelphia, U.S.A. for the determination of species of this cavernicolous cricket. One of us (K.M.S.) is also thankful to Prof. R. K. Khanna, and to Shri R. C. Mandraha, for their help.

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A NEW SPECIES OF GENUS *DACUS* FABRICIUS (TEPHRITIDAE: DIPTERA) FROM INDIA[1]

PREMLATA AND AWTAR SINGH[2]

(*With six text-figures*)

INTRODUCTION

The genus *Dacus* was first erected by Fabricius in 1805 for the type species *Dacus armatus.* Since then many subgenera have been described under genus *Dacus,* the subgenus *Bactrocera* (=*Strumeta* Walker 1856) being the largest group among them. It is differentiated from the rest of the subgenera by the presence of a row of cilia on each side of 3rd tergum; a single pair of Scutellar bristles; and by the 5th sternum of male with a deep V-shaped concavity on the hind margin. This note describes a new species, *Dacus* (*Bactrocera*) *cocciniae* sp. nov.

Dacus (Bactrocera) cocciniae sp. nov.

MALE:

Head: yellow except brown eyes; frons yellow, slightly fulvous towards ocellar triangle, 2 pairs of inferior orbitals; ocellar triangle brown, ocelli pale; antennae as long as the face, 3rd antennal segment 3 to 4 x longer than wide, arista bare; face yellow with 2 sublateral small black spots, proboscis long, geniculate and hairy, palpi short and rufous.

Thorax: rufous with humeral calli, notopleural calli, mesopleuron and scutellum yellow, no post sutural yellow vittae, thoracic chaetotaxy much reduced with 4 scapulars, 2 notopleurals, 1 mesopleurals, 2 posterior supra alars and 2 scutellars; anterior supra alar and prescutellar bristles absent.

Legs yellow with brown tarsi.

Wings: hyaline with light fuscations along costa and anal spine, vein R_4+_5 spinose till the level with 'm' cross-vein; supernumerary lobe distinct.

Abdomen: rufous yellow with 2 sublateral black spots on 3rd tergite which also possess a row of cilia on postero lateral border, 5th sternum with a deep V-shaped concavity.

Male terminlia

Periphallic organs: ninth tergite fulvous almost rectangular above tapering below to surstyli, covered with dense pale bristles; surstyli broad at base ending in a small anterior lobe and a slightly longer posterior lobe, outer clasper well developed bearing 2 equal prensisetae, 3 marginal and 5 submarginal bristles; decasternum yelow, bristly and quadrangular in shape.

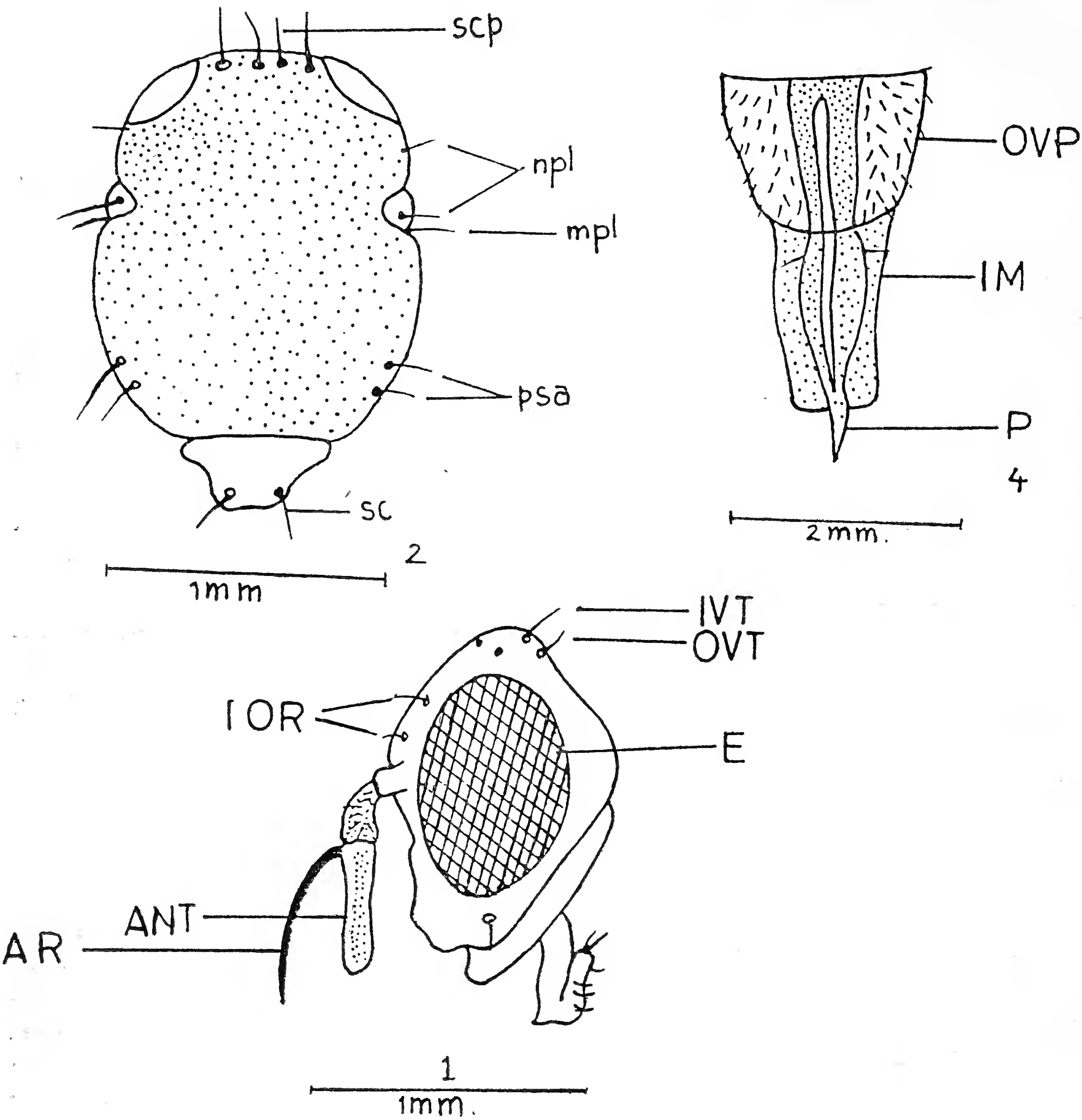
Phallic organs: genital ring simple,, fultella andiron type, median rod bifid posteriorly, vanes elongate, phallic apodeme short and slender, phallobase ring like; aedeagus highly sclerotized leaving the base, vesica and apical tube non-sclerotized, phallotheca long and looped, ejaculatory apodeme large, fan broad with narrow base and long stem.

FEMALE:

Resembles the male but has the following differences; supernumerary less developed; pecten absent; abdomen longer and slender than the male.

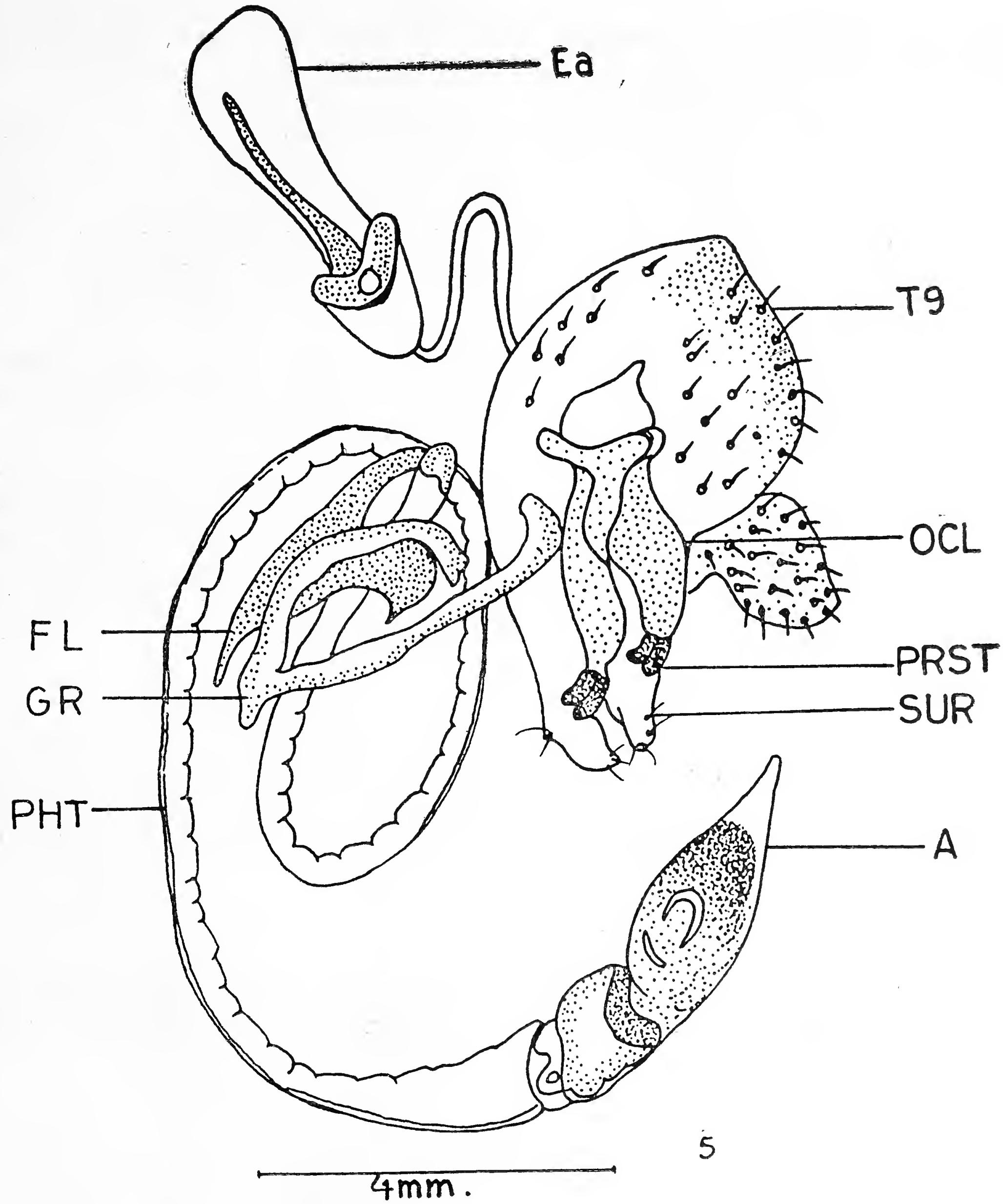
[1] Accepted February 1986.

[2] Dept. of Zoology, Punjab University, Chandigarh (India).



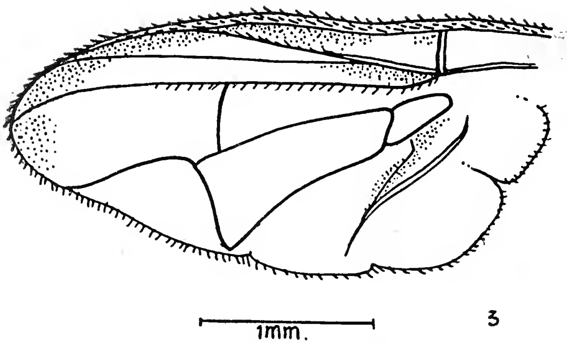
Dacus (*Bactrocera*) *cocciniae* sp. nov.
1. Head; 2. Thorax; 4. Ovipositor.

Abbreviations:
ANT, Antennae; AR, Arista; E, Eye; IM, Inversion membrane; IVT, Inner verticals; IOR, Inferior orbitals; mpl, mesopleurals; npl, Notopleurals; OVP, Oviscape; OVT, Outer vertical; P, Piercer; psa, Posterior supra alar; sc, Scutellar; scp, Scapular.



Dacus (*Bactrocera*) *cocciniae* sp. nov.
5. Male Terminalia.

Abbreviations:
A, Aedeagus; Ea, Ejaculatory epodema; FL, Fultella; GR, Genital ring; OCL, Outer clasper; PHT. Phallotheca; PRST, Prensisetae; SUR, Surstylus; T9. Sinth tergite



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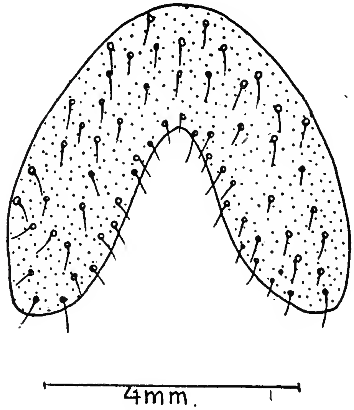

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Dacus (*Bactrocera*) *cocciniae* sp. nov.
3. Wing; 6. Fifth sternum of male.

Ovipositor: long measuring 0.7 mm, oviscape pubescent, inversion membrane as long as oviscape, piercer long and pointed.

Material Examined: Holotype ♂ Chandigarh, 21.xi.1985, *Coccinia indica,* coll. Premlata; Allotype ♀ same data, 6 Paratype, 2 ♂♂, 4 ♀♀ same data as holotype. Types in Entomology Section, Department of Zoology, Panjab University, Chandigarh.

Length of male 5.6 mm; Wing 4.3 mm.
Length of Female 5.2 mm; Wing 4.1 mm. (excluding the ovipositor).

Remarks: The species is near to *Dacus* (*Bactrocera*) *tillyardi* Perkins in the absence of yellow post-sutural vittae but can be differentiated from it by the lack of anterior supra alar bristles and prescutellar bristles and rufous yellow body colour.

Acknowledgements

One of us (Premlata) thanks the CSIR for granting her S.R.F. We thank the chairman, Department of Zoology, Panjab University, Chandigarh for providing laboratory facilities.

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A NEW SPECIES OF GENUS *LITHURGUS* LATREILLE, (HYMENOPTERA: APOIDEA: MEGACHILIDAE), FROM INDIA[1]

RAJIV K. GUPTA[2] AND V. K. TEWARI[3]

(*With five text-figures*)

The genus *Lithurgus* Latreille, from India was represented by 5 species: *atratus* Smith, *dentipes* Smith, *australior* Cockerell, *taprobanae* Cameron and *lissopoda* (Cameron). A new species *Lithurgus* (*Lithurgopsis*) *tiwarii* has been described for the first time from Pondicherry (India). It has some affinities with *L. australior* Cockll.

The genus *Lithurgus* Latreille, from Indian region was so far represented by 5 species namely: *Lithurgus* (*Lithurge*) *atratus* Smith, *L.* (*L.*) *dentipes* Smith, *L. australior* Cockerell, *L. taprobanae* Cameron and *L. lissopoda* (Cameron). The subgeneric placement of the former two species has been done by Michener (1965). Following are the characters which can distinctly separate genus *Lithurgus*, from rest of the megachiline genera:

'jugal lobe in posterior wing about 3/4th as long as vannal lobe; vestibule reaching upto mid-mesosomal segment; dorsally, hind tibiae coarsely or finely spiculate and pygidial area well developed in male, in female represented by a short spine'.

The new species described here, falls under subgenus *Lithurgopsis* Fox, on the basis of the following characters:

Facial mid-line may or may not carinate but never grooved; claws with well developed pulvellus in males; abdominal (tergal and sternal) apical fasceae may be lacking, widely interrupted or feebly developed; only 6 sternal plates are exposed in males, 7th & 8th retracted.

Lithurgus (Lithurgopsis) tiwarii[4] sp. nov.

MALE:

Integument of head and thorax with rugose appearance, abdomen shining; facial pubescence golden yellow, rest of the body with silky-white (plumose) hairs, last tergite with thick black bristles; integument black.

Head wider than the median length; inner eye margin convergent below and incurved at median area, carina distinct and close to eye; 2/3rd of the clypeus base strongly convex, margin feebly incurved; maximum width of parocular area equal to the basal width of clypeus; median line indistinct; vertex margin slightly incurved and incarinate; genae narrowed below and hypostomal area with dense pale pubescence; mandible tridentate.

Pronotal ridge low and obscure; scutum evenly convex; notauli not at all markable; scutellar surface resembles scutum, posterior margin broadly rounded; median length of propodeal triangle is about twice that of median groove below; wing colour clear hyaline, veins brownish-black, both recurrent veins reaches at the base and apex of the second

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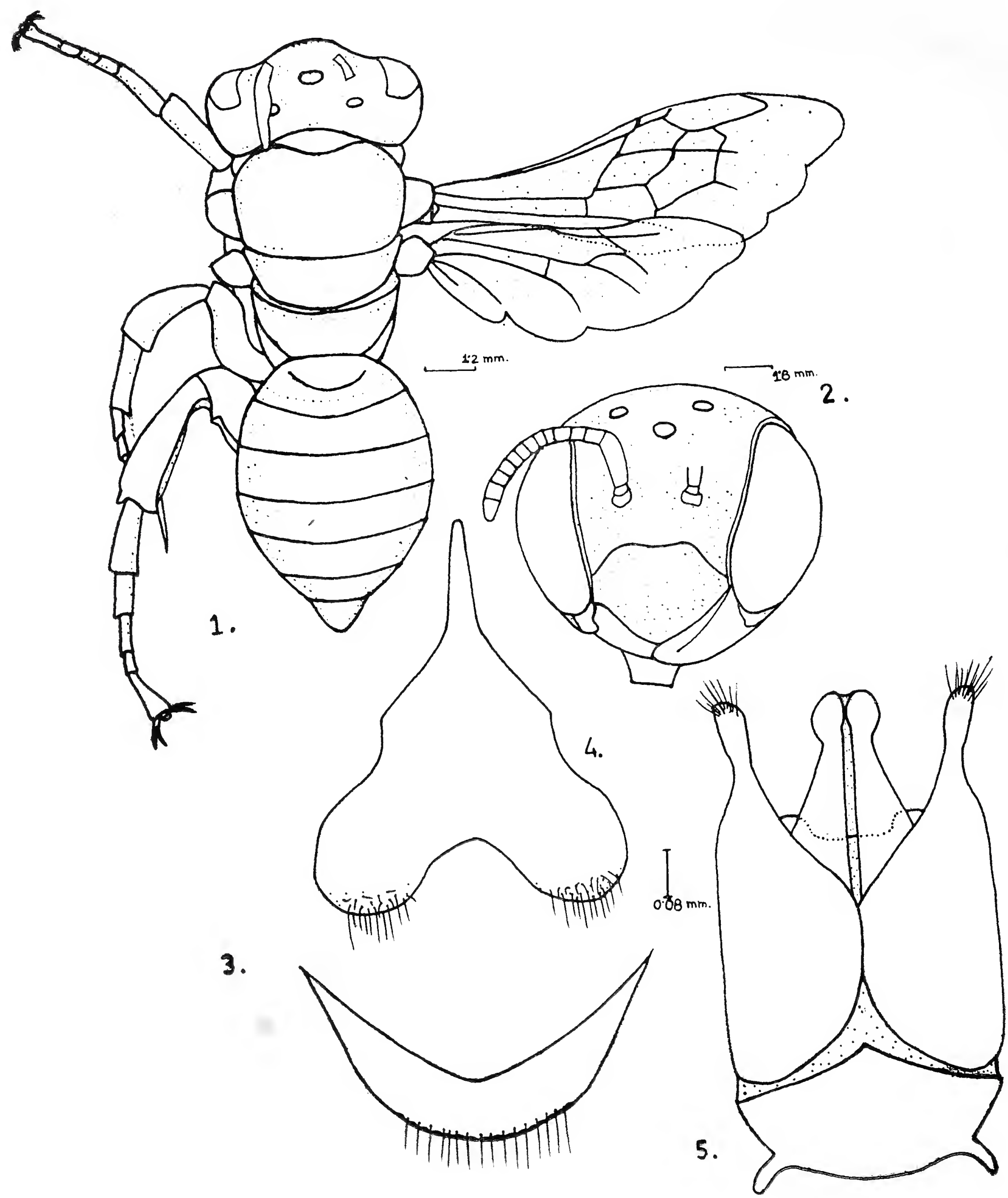
[4] After the name of one of the authors.



Figs. 1-5. *Lithurgus* (*Lithurgopsis*) *tiwarii* sp. nov., ♂
1. adult full dorsal view; 2. head front view; 3. sternum 7th; 4. sternum 8th; 5. genitalia.
(Dots on figs. 1 & 2 indicate pubescence).

cuboital cell. Apical margin of coxae shallowly grooved and with a smooth tubercle at trochanter base attachment; apical width of trochanter lesser than its median length; fore leg femora with a subdivided carinate ridge at apex (dorsally), spur testaceous yellow, bifurcated and with a fine fringe of hairs at the apices.

Basal tergum with concavity margin incarinate but hairy, apical margin with rudimentary fringe at lateral sides; in tergite 2-5: graduli indistinct & apical fasceae absent at midline; tergum 7th apical margin broadly rounded, medially thick and in 8th sternum, median invagination of apical lobe is quite deep with both halves bearing dense fringes projecting apically.

Gonocoxites protuberent upto medio-basal area, broadly convex; stipites dorso-ventrally flattened and with a broad apex, lobate; either sides of the basal margin of gonobase are produced to acuteness.

Measurements: (in mm.) Total length 8.5; eyes: length 2.07, lateral width 1.0; clypeus: median length 0.9, basal width 0.42, apical width 1.5; antennae; length of scape 0.65, pedicel 0.25, flagellar segments Ist – 0.22, IInd – 0.1, XIth – 0.23; labrum: median length 1.05, basal & apical width 1.25 & 0.9; mandible: length of lower & dentate margins 2.0 & 0.9; labial palpi: length of segment Ist 2.0 & IInd 4.0; scutum: median length 2.25 & maximum width 2.75; total length of fore wing 6.5; relative median width of tergite I to VII: 2.5, 3.25, 4.0, 3.2, 2.75, 1.5, 0.5.

FEMALE: not known.

Material examined: Holotype: male, paratype: 1 male both type specimens are at I.A.R.I., New Delhi.

Collection: Holotype as well paratype were collected from Mahatma Gandhi Park, Pondicherry (m.s.l.) on 4.vii.1981 (Gupta).

Flower record: *Solanum* sp.

Remarks: The new species is close to *australior* Ckockll. with respect to the subgeneric characters, detailed above (*australior* has also been placed under subgenus *Lithurgopsis* Fox), however, *australior* can be distinctly separated *tiwarii* sp. nov. by:
"clypeal protuberence limited upto half of the basal region; facial pubescence white; fore tibial dorso-apical projection absent; abdomen comparatively much elongated, apical margin of VIIth tergum with a prominent median spine; lateral acute projections of gonobase absent, stipites narrowed down gradually and penis valve wide".

ACKNOWLEDGEMENTS

We thank Dr. H. N. Baijal, Head of the Zoology Department, Agra College, Agra, for providing necessary facilities and to Drs. S. I. Farooqui, S. L. Gupta both senior scientists at Entomology Division, I.A.R.I., New Delhi, who kindly reviewed the manuscript.

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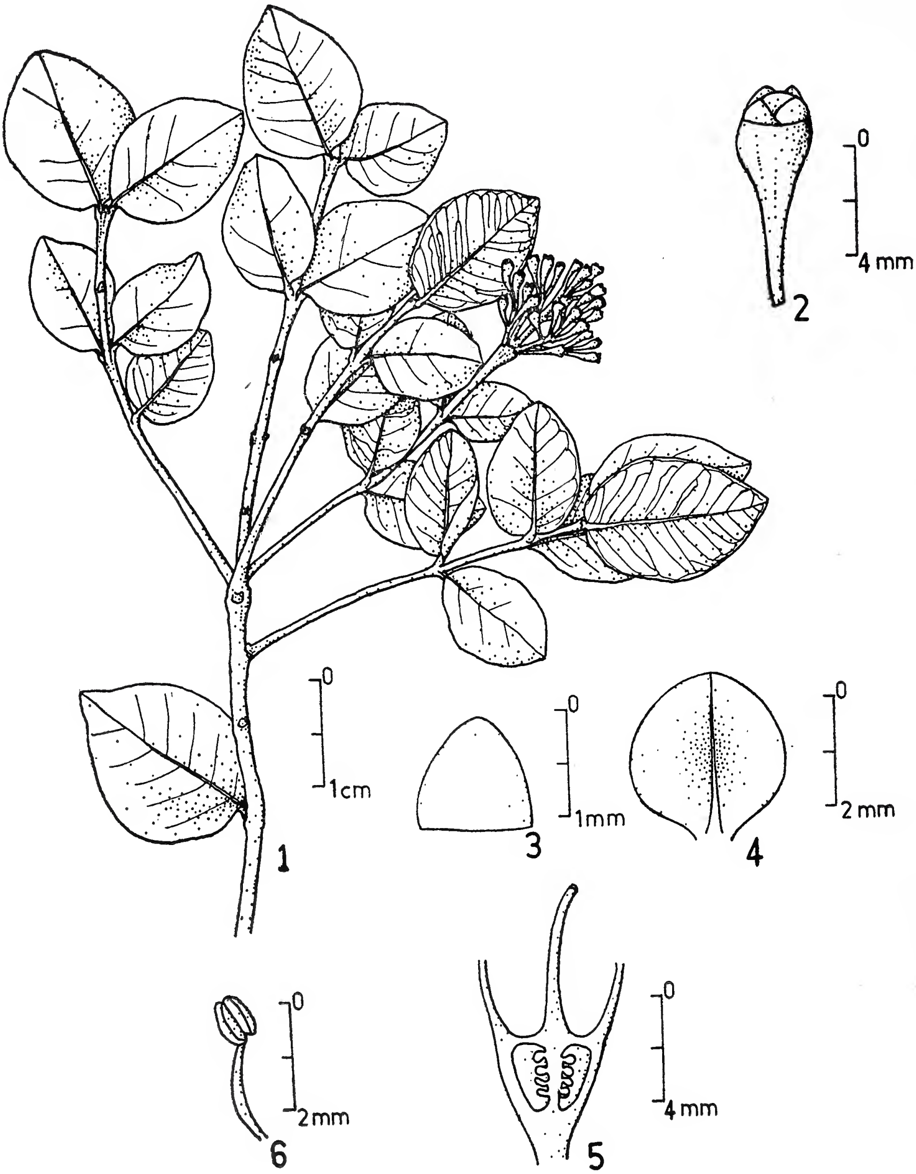
SYZYGIUM PARAMESWARANII (MYRTACEAE) — A NEW SPECIES FROM SOUTHERN INDIA[1]

M. MOHANAN AND A. N. HENRY[2]

(*With six text-figures*)



Figs. 1-6. *Syzygium parameswaranii* sp. nov.
1. Twig; 2. Flower; 3. Sepal; 4. Petal; 5. L. S. of ovary; 6. Stamen.

[1] Accepted July 1986.

[2] Botanical Survey of India, Coimbatore-641 003.

During systematic studies on the flora of Trivandrum Dt., Kerala for a period of over five years, several rare and interesting plants were collected. A new species of *Syzygium* Gaertn. (Myrtaceae) collected during the above period is described with illustrations.

Syzygium parameswaranii sp. nov.
(Figs. 1-6)

Syzygium calophyllifolium Walp. affiinis, sed floribus magnioribus pedicellatis (pedicellis usque ad 3 mm), lobis calycum magnioribus ovatis conspicus in gimm as imbricatis, foliis magnioribus (usque ad 4.5 cm) ad superas conspicue et arte nervatis differt.

Trees 4-6 m tall; ultimate branchlets tetragonous. Leaves 2.5-3 x 2-3.5 cm, opposite, sessile, coriaceous, ovate, obtuse or subacute at apex, rounded at base; midrib prominent; secondary lateral veins close, conspicuous; margins recurved. Panicles *c.* 2 × 2 cm, glabrous, subsessile, condensed, many flowered. Flowers *c.* 8 × 2.8 mm, funnel-shaped; pedicels 3 mm long, slender, glabrous. Calyx tubes *c.* 0.3 mm; lobes 4, each *c.* 1 × 1 mm, ovate, obtuse at apex. Petals 4, each *c.* 3 × 2.5 mm, suborbicular, obtuse at apex, gland-dotted along the main nerve. Stamens 3 mm long; filaments dilated at base. Ovary 2-loculed with many ovules in each locule; style 3 mm long; stigma simple.

Holotype *M. Mohanan* 66051 (CAL) and isotypes *M. Mohanan* 66051 (MH acc. no. 136392-93), were collected from the western slopes of Agastyamalai in Trivandrum Dt., Kerala (Alt. ± 1600 m) on 5.3.1980.

The new species is allied to *S. calophyllifolium* Walp. but differs by the larger, pedicelled flowers; larger ovate, conspicuous calyx lobes imbricate in bud; and larger leaves with conspicuous veins close above .

This rare tree grows along grassy western slopes of Agastyamalai in close association with *Pittosporum* spp.

Flowering: Jan.-April.

We are thankful to Dr. V. J. Nair, Botanical Survey of India, Coimbatore for rendering the Latin translation.

We are pleased to dedicate this species to Dr. M. Parameswaran Nayar, Director, Botanical Survey of India, Calcutta for his significant contributions to the systematics and phytogeography of Indian plants.

ON THE IDENTITY OF THREE NEW SPECIES OF *URGINEA* (LILIACEAE)[1]

D. B. Deb and Syamali Dasgupta[2]

Deb and Dasgupta (1974, 1981) studied the taxonomy of the genus *Urginea* Steinh. (Liliaceae) in India. Jessop (1977) in his studies on the bulbous Liliaceae in South Africa reduced *Urginea* to a synonym of *Drimia.* Accordingly Ansari and Raghavan (1980) changed the names of Indian *Urginea* to *Drimia*, and Ansari (1981) described a new

[1] Accepted June 1985.
[2] Botanical Survey of India, Howrah.

species. Deb and Dasgupta (1983) reviewed the generic status of *Urginea* in course of which they upheld the distinction between *Urginea* and *Drimia,* for which new combinations proposed by Ansari and Raghavan (l.c.) stand superfluous and illegitimate, and the new species *Drimia rajii* Ansari (1981) deserves a new combination.

Detailed investigation on taxonomic significance of morphological characters and their range of variation in altitudinal and geographical distribution reveals that *U. coromandeliana* and *U. wightiana* are not distinguishable from *U. indica* by any qualitative character. Hooker f. (1892) distinguished *U. coromandeliana* from *U. indica* for persistent bracts, smaller bulbs and linear leaves, and (2) *U. wightiana* for long pedicels, broad filaments and narrow elongated style. Recent collections close up the distinction. Specimens are extant having bigger bulbs with linear leaves (Ramamurthy 16028 MH); smaller bulbs with broader leaves (*D. Prain* s.n. CAL; *Rukmini Bai* 134 BLAT); bigger bulbs with persistent bracts (*J. Joseph* 12439 MH); and characters intermediate between two extremes (Barnes 2179 K). On the other hand, there are specimens with long pedicel, narrow filament, and short style (*S. Kurz* s.n. CAL); long pedicel, broad filaments, and short style (*Santapau* 13702 BLAT), and short pedicel, narrow filament and long style (*Fischer* 3783 MH). These evidently indicate that such variations are of no taxonomic significance for which these three are treated as conspecific (Deb and Dasgupta, l.c.). Workers who are not familiar with taxonomic significance of morphological characters in a group may hesitate to accept conspecificity on examination of some isolated plants. But this is unavoidable for the sake of taxonomy.

Urginea indica is distributed nearly throughout India from Gujarat and Maharashtra extending to tropical Africa in the west, to Bihar, Orissa and Burma in the east, Himalayan border of Uttar Pradesh and Nepal in the north and down to Tamil Nadu in the south. It grows from the sea level to 2600 m in altitude, in dry habitats, such as sandy gravel, sandstones and soils derived from garnetiferous gneiss and khondalite. It is found in the *Pine* forest in the Western Himalayas and *Dipterocarpus* forest in Burma.

The species is known as hysteranthus. But *Shaik Ismail* 222 (CAL) collected from Akyab, Burma, on 21.1.1907 bears simultaneously leaves, flowers and fruits, showing thereby, that this is not strictly hysteranthus and that this phenomenon is influenced by the ecological condition prevailing on the locality in which it grows.

Chromosome numbers of *U. indica* were determined as 2n = 20 by Raghavan (1935, 1940) and Kishore (1957). Triploidy also was observed in it by Raghavan (l.c.). Jha and Sen (1985) observed diploid, triploid, tetraploid and hexaploid races of 20 cytotypes in different populations of *U. indica* distributed in south Indian states. They further observed a high degree of genotypic variability in natural populations. Their observation is in conformity with the taxonomic significance of morphological variations in the genus as expounded by Deb and Dasgupta (l.c.).

U. govindappae Boraiah et Fatima (1970) has been reduced to a synonym of *U. indica* by Deb and Dasgupta (l.c.). Boraiah and Fatima (1982) could not accept the reduction of their species, for some variation in forms of bulb and leaf as well as chromosome configuration in their material and that the type specimen was not examined at that time.

Deb and Dasgupta (1974) considered all

these points before reducing the species to a synonym. They examined a specimen from the type locality as determined by the authors of the species since the holotype was not sent to CAL by that time. In the mean time they examined the type presented to CAL and find that their views are correct. Forms of the bulb and leaf are covered by the range of variation of these parts in *U. indica.* Cytological studies conducted by Jha and Sen (1985) are in full agreement with the reduction of that species so far as chromosomal differences are concerned. Any difference in chromosomal configuration if not followed by any qualitative change in morphological characters cannot be the basis for taxonomic distinction of a species. Thus *U. govindappae* stands reduced to a synonym of *U. indica.*

U. nagarjunae Hemadri et Swahari (1982) has been described on the basis of bulbs collected from Bhata village, Nellore district, Andhra Pradesh and grown in the experimental garden, Vijayawada. The authors distinguished the species by the stouter scape, closer flowers, non reflexed perianth segments, larger bulbs, broad leaves and bigger gynoecium. They included in this species *Fischer* 3783 (MH) which was treated by Deb and Dasgupta as *U. indica* with a note that it shows gigantism.

Reflexed perianth segment is not of taxonomic significance. In both the species perianth segments are erect when young and spreading when matured. Hemadri & Swahari noted closer flowers in having 20-75 flowers in 15-28 cm long raceme. In *Fischer* 3783 (MH) there are 18 flowers in 25 cm long raceme as is the case with *U. indica.* As regards quantitative characters bulb size in *U. indica* varies from 2.5 to 10 cm in length which includes the range given for *U. nagarjunae.* In size of scape, breadth of leaves, length of gynoecium etc., the upper limit in *U. nagarjunae* is higher than that of *U. indica,* but there is continuity in variation and *Fischer* 3783 (MH) is intermediate in position. Another fact that needs to be considered here is that their plant was grown in nursery and it flowered under cultivated condition. It is well established that a cultivated plant shows variations from the typical one in natural habitat.

In consideration of all these facts it is evident that *U. nagarjunae* is not taxonomically distinct from *U. indica* and deserves to be reduced to a synonym as follows:

U. indica (Roxb.) Kunth, Enum. Pl. 4: 333. 1843; Deb et Dasgupta in Bull. Bot. Surv. India 16: 118. 1974 & Fascicles Fl. India 7:17. 1981.

Scilla indica Roxb. Fl. Ind. 2: 148. 1832 (Type: *W. Roxburgh* s.n.)

S. coromandeliana Roxb. (Type: *W. Roxburgh* s.n.)

Urginea senegalensis Kunth, Enum. Pl. 4: 334. 1843.

U. coromandeliana Hook. f. Fl. Brit. Ind. 6: 347. 1892.

U. wightiana Hook. f. Fl. Brit. Ind. 6: 347. 1892 (Type: *Wight* s.n.)

U. govindappae Boraiah et Fatima in Bull. Bot. Surv. India 12: 128. 1970 (Type: *Boraiah et Fatima* 601! CAL).

Drimia indica (Roxb.) Jessop in Journ. S. Afr. Bot. 43: 312. 1977.

U. nagarjunae Hemadri et Swahari in Ancient Sci. Life 2: 105. 1982. (Type: *Hemadri* 3001 A! holo CAL; *Hemadri* 2925 A! para CAL), *synon. nov.*

Drimia rajii Ansari (1981) is stated to have the holotype and one of the isotypes deposited with CAL, but these are not yet sent here for which no specimen could be examined. However, it is quite evident from the description and the illustrations that this is a distinct one

and deserves a new combination as follows:

Urginea rajii (Ansari) Deb et Dasgupta comb. nov.

Drimia rajii Ansari in Journ. Bombay nat. Hist. Soc. 78: 572. 1981.

As a new species has been added to the genus a revised key to the species is given:

KEY TO THE SPECIES

1a. Pedicels shorter than bracts; flowers few .... *U. polyphylla*

1b. Pedicels longer than bracts; flowers many
- 2a. Pedicels 10-35 mm; racemes loose .... *U. indica*
- 2a. Pedicels 4-8 mm; racemes dense
  - 3a. Bracts persistent, not squrred .... *U. polyantha*
  - 3b. Bracts evanescent, spurred
    - 4a. Capsule ovate-oblong; perianth 8-9 mm long .... *U. rajii*
    - 4b. Capsule subglobose; perianth ± 5 mm long .... *U. congesta*

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A NEW SPECIES OF *LASIANTHUS* (RUBIACEAE) FROM BURMA[1]

D. B. DEB AND MOHAN GANGOPADHYAY[2]

(*With a text-figure*)

Lasianthus meeboldii sp. nov.

Species haec ab *L. curtisii* King et Gamble differt folio latiore, stipula breviore, inflorescentia sessili, calyce dentibus minutibus, fructibusque pubescentibus.

Typus: Burma, Tenasserim, Yaundan, March, 1911, *A. Meebold* 14790 holo. CAL; Mergui, Sandawut reserve, 50′, 31.1.1919, **C. G. Rogers** 440 m para. CAL.

[1] Accepted July 1986.

[2] Botanical Survey of India, Indian Botanic Garden, Howrah.

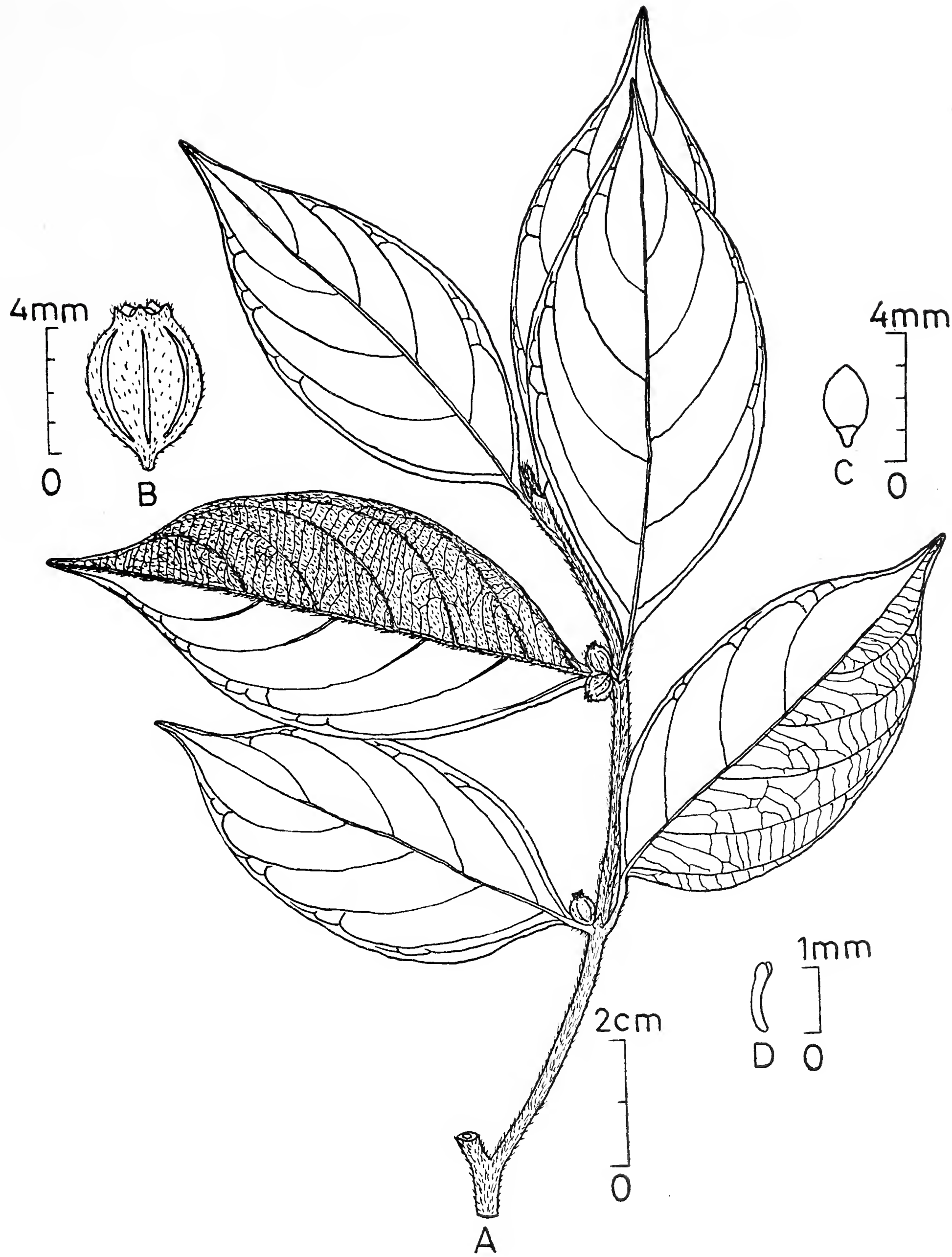

Fig. 1. *Lasianthus meeboldii* sp. nov.
A. Habit; B. Fruit; C. Seed; E. Embryo.

Differs from *L. curtisii* King et Gamble in broader leaves, sessile inflorescence, minute calyx teeth, shorter stipules and pubescent fruit amongst others.

Under shrubs 30-60 cm high; branchlets ferruginous pubescent; younger ones compressed, terete in age; raphides present. *Leaves* petiolate, 5-8 × 3-4 cm, more or less oblong, acuminate at apex, acute at base, slightly incurved at margin, subcoriaceous, glabrous above, ferruginous pubescent beneath; midrib conspicuous below; lateral nerves sub-opposite, 5-6 on either side, arcuate, faint above; nervules subparallel, forked, slender beneath; petioles 4-6 mm long, slender, pubescent; stipules deciduous, ± 1 × 1 mm, triangular, acute, pubescent. Infloresecence axillary, sessile, fascicled, ebracteate. *Calyx* persistent; lobes 4 or 5, triangular, pubescent. Other parts of the flower not seen. *Fruits* blue, 2-3 × 2-3 mm, globose, ovoid, sessile, pubescent, crowned with persistent calyx lobes, slightly ridged and furrowed, without raphides; exocarp and mesocarp thin; endocarp thick; pyrenes 5, dorsally convex, ventrally angled. *Seeds* ± 2.5 × 1.5 mm, plano-convex, ellipsoid, acute at apex, smooth; albumen uniform; embryo ± 2 mm long; axis ± 1.7 mm long, semi-terete, shallow grooved at base; cotyledons ± 0.3 mm long, ovate, obtuse at apex; funicle short.

Type: Burma, Tenasserim, Yaundan, March 1911, *A. Meebold* 14790 holo. CAL; Mergui, Sandawut reserves, 50′, 31.1.1919, *C. G. Rogers* 440 m para, CAL.

REVIEWS

1. SHOREBIRDS IN AUSTRALIA. Text by Brett Lane, illustrations by Jeff Davies. pp. 187 (29 × 21.5 cm), with 19 colour plates and many black-and-white photographs, graphs & maps. Melbourne, 1987. Nelson publishers. Price not mentioned.

This is the kind of book that one would like to see about Indian birds. In addition to the extensive shorelines there are in Australia large inland areas which have become saline lakes with gently sloping shores which provide the right conditions for the waders. Some of the migrants are identical with those occurring in India, while others are species straying into Assam and Eastern India but about which we know very little. Indian ornithology so far has been almost completely divorced from information from further East and more particularly from that from Australia.

The migratory records both from within and outside Australia are well presented and indicate possibilities of further work in India. This work is the compilation of the efforts of about 700 birdwatchers organised by the Royal Ornithologists' Union and a revelation of what can be achieved by widespread collaboration, a factor sadly missing in India. Curiously one bird ringed in Australia and recovered in India (*Calidris testacea* CSIRO Canberra, Australia 040-92431) is omitted in those listed.

The whole text is excellently illustrated both in black and white and colour and a detailed and careful perusal particularly of the portions relating to Feeding Behaviour, Ecology, Migration and Internal Movements together with a bibliography of 498 titles indicate the value of the book together with immediate possibilities of further work in India.

HUMAYUN ABDULALI

2. INVERTEBRATE ZOOLOGY. By Paul E. Lutz. pp. xvii + 734 (24 × 19 cm), with many illustrations. U.S.A., 1985. Publishing Company. Price not mentioned.

Of the approximately 1,100,000 animal species known to us, almost 1,070,000 are invertebrates; only 3.4% are backboned animals. It is but natural that many books are devoted to a study of the vast array of these apparently unimpressive, but not insignificant, animals. Lutz's book is one of the latest to have been published.

Unlike many of the college books on invertebrates which we often come across, this is not just a book which students use; it is written for students. Careful attention has been paid to reflect good pedagogy, and thus to entice the student intellectually into a progressively engrossing study.

Forty phyla are covered in 17 chapters. Each chapter begins with an overview, followed by a detailed section dealing with the overreaching principles, features and characteristics common to the entire group. Inter-relationships of the general morphological and physiological features are given to denote adaptations to

the different environmental conditions. Then comes a somewhat briefer treatment of the principal diagnostic features of the main subordinate groups, and concludes with a thumbnail taxonomic resumé of the most important characteristics of each major group, usually down to ordinal level. These themes are woven into each chapter, viz. unity amid diversity, evolution and ecology.

As is the current trend, the former Classes of the phylum Protozoa are here described as seven separate phyla. The earlier phylum Bryozoa or Polyzoa is nowadays divided into the two phyla Ectoprocta and Entoprocta; these are called Bryozoa and Entoprocta by Lutz. Of the minor phyla — so called because each contains very few species, Gnathostomulida is akin to Platyhelminthes and Nemertea, Placozoa and Mesozoa are allied to Porifera, while Pogonophora, Sipuncula, Onychophora and Echiura are phylogenetically related to Annelida. The remaining eight minor phyla, viz. Priapulida, Tardigrada, Pentastomida, Phoronida, Brachiopoda, Chaetognatha, Hemichorda and the non-vertebrate Chordata are not closely related to other larger phyla.

A few important bits of information for some of these are worth repeating and would not be amiss here.

The phylum Placozoa is represented by only one known species, *Trichoplax adhaerens*, which was discovered in 1883 but was mistaken as a larval stage of a coelenterate until its rediscovery in 1969. It has been described in 1971 by K. G. Grill in volume 24 of *Naturwissenschaftliche Rundschau.*

The phylum Mesozoa has some 50 species —minute worm-like creatures from 0.1 to 9 mm in length.

The Class Remipeda of Crustacea, represented by a single known species, *Speleonectes lucayensis*, was discovered in 1980 from a submarine cave. It is described by J. Yager in volume 1 of the *Journal of Crustacean Biology* (1983).

One species of the phylum Loricifera, viz. *Nanaloricus mysticus*, was described by M. Kristensen in *Zeitsch. Zool. System. Evolut.-forsch*, volume 21 (1983). Other species have since been collected from the interstices of shelly marine gravel. They have a Higgins larva.

Among the minor phyla, the Pentastomid tongue worms live in the lungs and nasal passages of lizards and other carnivorous vertebrates (including man), while the microscopic (10.3 to 10.5 mm) Tardigrada (water bears) live in the watery film on terrestrial mosses. The animals of all the other minor phyla are marine and, with the exception of the planktonic Chaetognatha, are benthic.

Lutz has not treated the new Class Concentricycloidea, which was discovered after his book was published. It is represented by *Xyloplax medusiformes*, a minute (2 to 9 mm) medusa-like animal attached to wood from depths of 1035 metres. It lacks a mouth, anus and arms, but has a pentamerous symmetry, tube feet and a typical Echinoderm skeleton. It was described by Alan Baker, Helen Clark and Francis Rowe in No. 321, pages 862-864 of *Nature* of 26 June, 1986, and also in the *New Scientist* of 3 July, 1986.

The author seems to be unduly fond of the theme "unity amid diversity", as this is repeated no less than six times — twice in the preface, on page 1 of the introduction, then twice on page 2, and again on page 13. It may not be the author's fault but, to Indian readers who are bored to death with this cliché phrase being said time and again by our statesmen and politicians, it does leave a jarring note.

The author, in his boundless enthusiasm, has been carried away to the extent of using a rather prosy opening gambit. It runs thus:

"Welcome to the wonderful, incredible, fascinating world of invertebrates. You are about to embark on a study of the most enchanting, remarkable, and diverse living things known, and I certainly hope to generate in you some unbridled enthusiasm for this captivating group of beasts." In the beginning I wondered whether this mellifluous, verbose language shielded a lot of pedantry but, as I went through the book, I realized that it was written by an erudite scholar.

The book is well edited; I could locate only one error, on page 111 (line 31 in the right column), where "mesogleal" is wrongly spelt as "mesogeal". A technical error has also crept in on page 8, where the author defines "compensation point" as the level "below which no photosynthesis is possible". (Actually, "compensation depth" is that depth where the amount of oxygen produced by photosynthesis equals the oxygen consumed in respiration by a plant.) Another, albeit insignificant, error is that the author, in his preface, has given Remipedia as a subclass, while elsewhere in the book it is given the status of a class.

All the line drawings in the book are invariably of an excellent standard, but many of the photographs leave much to be desired, and could easily have been dropped, since many of them are repetitions of drawings. Examples: Fig. 5.12, hydroid colony; 6.16a, fluke; 8.14b, Chaetopleura; 8.28b, Atrina; 9.9g, Halosydna; 12.28a, Idothea; 12.30a, Penaeus; 13.34a, tree hopper; and 17.31d, Stichopus. Especially sticking out like a sore thumb is Fig. 11.13f, depicting the web of Aranea.

These few detractions, however, do not deter from the excellence of the book, which is a "must" for college libraries and zoology teachers.

B. F. CHHAPGAR

MISCELLANEOUS NOTES

1. NEONATAL MORTALITY AMONG SOME CAPTIVE MAMMALS AT NANDANKANAN ZOO

The purpose of this communication is to highlight the importance of neonatal mortality data for animals in captivity.

Data on neonatal mortality of 20 species of animals belonging to 5 groups based on postmortem examination and relevant history were obtained from Nandankanan zoo, Orissa, for the period 1967-1983. Most of the species included in this study were of Indian origin except lions which included lions of both Indian and African subspecies. The neonatal deaths were broadly divided into 4 types on the basis of deaths occurring at different periods of neonatal life. They were (1) still-births — born dead, (2) immediate hebdomadal deaths — deaths occurring within 24 hours of birth, (3) hebdomadal deaths — deaths occurring in 2-7 days of birth, and (4) post hebdomadal deaths — deaths occurring in 8-28 days of life.

Out of 722 deaths recorded in 20 species of animals (Table 1) belonging to different age groups. 242 (33.32%) deaths occurred during neonatal period. Among the species studied (Table 1) highest percentage of neonatal deaths ranging from 40.74 to 67.86 per cent occurred in members of felidae. Next in importance was in wild ruminants which ranged from 14.71 to 43.75 per cent. The results in other species were inconclusive as the number of observations were meagre. It was further seen that majority of deaths occurred during hebdomadal period in members of felidae and ruminants.

The common causes of mortality in different groups have been given in the Table 2. It was seen that still-births and debility were common in most of the groups and cannibalism and rejection by mother were frequently seen among wild felids apart from pneumonia and other miscellaneous conditions. It is possible that the high incidence of still-births in this study may be due to inbreeding as has been suggested by Roychoudhury (1980) and Roychoudhury and Sankala (1979). Apart from inbreeding, any disturbance during advanced stage of pregnancy may result in still-births and hebdomadal mortality. Therefore, to minimise the incidence of still-births, it is necessary to avoid inbreeding in captive animals by introducing fresh blood frequently into the existing livestock by exchange programme with other zoos/sanctuaries. Further, any disturbance to the pregnant/nursing mothers should be avoided by keeping them away from visitors.

According to Cooper (1942) and Schaller (1967), lioness in captivity occasionally eat their young ones but in the present studies cannibalism was observed in all 6 species of felids under study but not in other species. Street (?) stated that zoo mothers often refuse to rear their offspring of the first litter though

TABLE 1

NEONATAL DEATHS RECORDED AMONG 20 SPECIES OF CAPTIVE WILD MAMMALS

Sl. No.	Species	Total deaths	Neonatal deaths: Still-birth	Immediate hebdomadal	Hebdo-madal	Post Hebdomadal	Total	Percentage
A.	FELIDS							
1.	Tiger	28	6	4	4	5	19	67.86
2.	Lion	22	1	5	3	2	11	50.00
3.	Leopard	61	3	10	9	14	36	59.02
4.	Leopard cat	27	–	–	1	10	11	40.74
5.	Golden cat	14	–	4	3	2	9	64.29
6.	Jungle cat	45	2	–	21	4	27	60.00
	Total	197	12 (10.62%)	23 (20.35%)	41 (36.29%)	37 (32.74%)	113 (57.36%)	
B.	WILD RUMINANTS							
7.	Hog deer	16	6	–	–	1	7	43.75
8.	Mouse deer	15	–	3	–	1	4	26.67
9.	Spotted deer	113	8	5	6	7	26	23.01
10.	Sambar	67	4	6	7	9	26	38.82
11.	Barking deer	80	3	2	3	10	18	22.50
12.	Fourhorned antelope	34	1	1	1	2	5	14.71
13.	Nilgai	17	3	2	–	–	5	29.41
14.	Blackbuck	83	5	2	9	4	20	24.10
15.	Indian Bison	6	–	–	–	2	2	33.33
	Total	431	30 (26.55%)	21 (18.58%)	26 (23.01%)	36 (31.86%)	113 (26.22%)	
C.	BEAR AND OTHER							
16.	Sloth bear	27	1	–	–	3	4	14.82
17.	Common otter	9	2	–	–	1	3	33.33
	Total	36	3 (42.86%)	–	–	4 (57.14%)	7 (19.44%)	
D.	PRIMATES							
18.	Rhesus monkeys	20	1	1	1	–	3	15.00
19.	Slow loris	24	–	–	1	–	1	4.17
	Total	44	1 (25.00%)	1 (25.00%)	2 (50%)	–	4 (9.09%)	
E.	SQUIRREL							
20.	Malayan giant squirrel	14	–	2 (40%)	3 (60%)	–	5	35.71
	Grand total	722	46 (19.01%)	47 (19.42%)	72 (29.75%)	77 (31.82%)	242	(33.52)

TABLE 2

CAUSES OF NEONATAL DEATHS IN 5 GROUPS OF CAPTIVE WILD MAMMALS

Group of Animals	Causes of death																
	Still-birth	Cannibalism	Traumatic injuries	Rejection by mother	Debility	Hydrocephalus	Pneumonia	Peritonitis	Intussusception	Gastro enteritis	Drowning	Killing by predator	FMD	Pyemia	Tympanites	Heat stroke	Unknown
Felids	12	43	1	25	16	1	4	1	1	3	—	—	—	—	—	—	6
Ruminants	30	—	1	4	34	1	17	2	1	2	3	7	1	1	2	2	6
Bear and Otter	3	—	—	—	1	—	3	—	—	—	—	—	—	—	—	—	—
Primates	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	1	—
Squirrels	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—

some mothers might rear their subsequent litters. Deaths due to rejection by mother tigresses in this study belonged to this category.

The age specific mortality among captive mammals during neonatal period in Indian zoos is lacking. According to Pant and Dhariyal (1979), mortality of tiger cubs in Delhi zoo was mainly due to either still-births or due to neglect by mother after birth. Out of 193 tiger deaths, 32% occurred during the first year of life. According to Saharia (1979) the mortality of tigers was 39% in 0-1 year age group. In a nationwide survey of causes of mortality among tigers, Rathore and Khera (1979) recorded 42 cub deaths (unspecified age) out of 62 tiger deaths which included still-births, navel ill, malnutrition, debility and infant mortality. Bhattacharya and Chattopadhyaya (1979) while studying mortality among blackbucks and spotted deer at Ballavpur wildlife sanctuary stated that the neonatal deaths accounted to 23-24% of the total 34 deaths. Schaller (1967) reported a fawn mortality of about 50% in spotted deer, sambar and Indian bison at Kanha National Park. This study revealed considerable loss during neonatal period and in ruminants and felids majority of deaths occurred during hebdomadal period.

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BARANG, CUTTACK, ORISSA,
September 15, 1987.

A. T. RAO

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2. REACTION TOWARDS SICK ANIMALS BY CONSPECIFICS IN THE COMMON GREY LANGUR (*PRESBYTIS ENTELLUS*)

The intriguing sight of the attempted revival of sick and wounded in the common grey langur (*P. entellus*) was noticed on four occasions. Two of the cases involved road accidents while the other two were caused by food poisoning and extreme low temperatures. Attempts at revival were made in only three of the four observed cases, all the three sick individuals being adult females. Two of the three adult females recovered while the third which was fatally wounded died.

The behavioural repertoire involved in the revival of all three adult females was strikingly alike and involved the following sequence:

1) Fellow group members sit around the sick animal;
2) partially lifting up, followed by vigorous shaking of the prostrate sick/wounded individual by a resident conspecific adult female;
3) jumping a few times (2-5) on the ventrothoracic and abdominal region of the sick/wounded animal by a second adult female;
4) The second female seated herself atop the body of the sick/wounded individual while other group members sniffed at its face.

The fourth incident involved the resident adult male of a unimale bisexual group. Diagnosis established the causal factor of death of the adult male as food poisoning. No attempt, what so ever, was made by fellow group members to reanimate the ailing adult male.

Besides bringing to light the inborn capabilities of langurs to attempt to revive their

sick, these four instances give us a deeper insight into the social dynamics of the Hanuman langur. The attempt, by fellow group members to revive only female conspecifics and not the resident adult male possibly relates to kinship that is prevalent among females, who form the stable core of the langur social organization. An adult male in a unimale bisexual group enjoys only a "transistory adult male" status, i.e. he is replaced by another adult male at some point in time. Further more the probability of relatedness between the adult male and the permanent members of a bisexual group is most probably low or nil. This could possibly account for the absence of co-operation (in this case attempt of revival) towards the ailing male.

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February 28, 1987.

R. MATHUR
A. LOBO

3. HYENA PREDATING ON A DOMESTIC CALF

On 19.11.1986 at about 6 a.m. while walking in an area near Chemmanatham Dam, bordering Mudumalai Wildlife Sanctuary, I noticed a striped Hyena dragging a calf along a footpath towards us. When it realised our presence it disappeared behind the bushes. I searched but could not locate the animal. In about 20 minutes villagers came enquiring about a Hyena which had carried away a calf. The mother of the calf was tethered, in the village when two Hyenas attacked the calf, which was about 10 days old and was sickly and dragged it away, before they could reach the spot. It is possible, they said that the calf was already dead when the Hyena carried it away. We all searched the area and saw 2 pups of the hyena playing. When they saw us they disappeared into a hole. Though I knew that there were Hyena dens in the area, this was the first times pups had been sighted. There were fresh drag marks leading to and disappearing into the hole. We quietly left the place.

WILDLIFE WARDEN,
MUDUMALAI WILDLIFE SANCTUARY,
UDHAGAMANDALAM 643 001,
TAMIL NADU,
December 18, 1986.

J. MANGALRAJ JOHNSON

4. THE WOLF (*CANIS LUPUS*) OF MEWAR REGION, RAJASTHAN

Udaipur City is surrounded by the Aravali Hills, East of Udaipur, beyond Debari gate there is a vast plain interspersed by hillocks. Before independence this plain teemed with antilope and other game animals. Wolves were in fairly good number in the plains. In hilly terrain where there were barren patches wolves were often met with. Most of the hilly area was dominated by the leopard *Panthera pardus*.

Gradually the large herds of Blackbuck (*Antilope cervicapra*) and other animals like Chinkara (*Gazella gazella*), Blue Bull (*Boselaphus tragocamelus*), Wild Boar (*Sus scrofa*) etc., disappeared from the plains. Most of the cervids totally disappeared and the plains are converted into agricultural fields. Hills are also practically denuded of forest. The ideal habitat of wolves has been claimed by man. Slowly the wolves receded to barren hilly tracts, Due to the absence of wild animals and change of habitat marked change can be observed in the habits of wolves of this region.

On 14.8.1978 I submitted a report to the then collector regarding the depredations of wolves east of Udaipur. Two packs were operating. The beat of one containing 8 animals was from Kurabar to Nawa village and the other pack of 5 animals operated from Ghorach to Shringrishi. Shringrishi is quite near to Nawa village and some time these two packs combined to form a big pack of 13 animals and wrought havoc in the area. To the best of my calculation these two packs in a year inflicted damage to the villagers of their beat to the extent of about one lack rupees. They used to kill goats, sheep and some time calves also. They never stayed in one locality for more than 24 hours.

The wolves around Udaipur used to breed in mid summer and this period has gradually shifted towards the rainy season. This year two litters were dropped in late June and early July. The reasons for this shift are lack of bush cover and disturbances caused by graziers to their breeding places. In the fifties the average size of a litter was between 4 to 6 pups. The size of a litter is also gradually declining. From 1970 to 1986 I got authentic report of 33 litters out of which the number of litter containing one pup was 11 and the remaining twenty two contained 2 pups each. Because of the shrinkage of habitat, it appears that nature is controlling their breeding power, a natural family planning! The villagers are bitter enemies of this animal but they are practically unable to control them so they unleash their vengeance on small pups. When ever they get the news of any litter they burn these helpless brutes alive in their dens.

This year I observed a most interesting and puzzling behaviour of the wolves. About thirteen miles on Udaipur Nathadwara road there is a village Delwara and a mile off from here is a hamlet called Goodly, situated at the base of a hill and right in front of it there is a cave in a ravine. Previously these hills were clothed with jungle and the cave was a permanent maternity home for leopards. As the Jungle as well as leopards disappeared this cave was used by Hyenas (*Hyaena hyaena*) and Jackals (*Canis aureus*) but they too were wiped out for their pelts. Now this cave is often used by wolves for littering. This year on 23rd June, 1986. Two pups of wolf were sighted outside the cave. The villagers became excited and planned to burn then alive.

The news was conveyed to me by Mr. Karan Singh Jhala ex-Jagirdar of the area who saved these animals.

The pups often come out of the cave for play and retreat back as soon as they sense any danger. When they grew a little bigger the responsibility of rearing was shared by both the partners who used to feed the pups with semi-digested food which they would vomit on a flat rock near the cave. After some time the pups were fed with raw meat by their parents.

The most striking feature of this littering was that as long as the wolves occupied the cave the dogs of the village remained silent, even in the night they seldom barked. This village lost on an average 12 to 16 thousand rupees worth of live stock annually. As long as these pups were their not a single

animal from this village was touched by these wolves though on several occasions they were seen passing quite close to the grazing herds of goats, and sheeps. On 6th August, in the morning the pups went out of the cave with their parents but returned back to the cave after going for about a 100 yards. This was repeated for three consecutive mornings on the fourth morning they left the cave and the parents killed a she goat of the Goodly village very near to the cave to which they did not return. In the afternoon the dogs of the village became active and started barking and during the whole night the dogs barked madly.

After a week the family returned back to the cave in late evening and were greeted by barking dogs. Next morning they left the cave for good and joined their pack. Nowadays a pack of eight animals is operating in this region. The pack consists of five adult and three sub adult animals.

As the wolves of this region have to depend upon domestic animals there is a marked change in their mode of killing. They try to disembowel the prey with amazing speed. After that they tear the prey into pieces and run away with the booty for atleast a distance of 5 to 6 km. before settling to eat. The tearing of their prey is so fast that it can not be seen and the method requires to be filmed for explaining the process. Attendents of the herds shout and pelt them with stones and chase them for long distances and if the prey or part of the prey is dropped by the wolf they pick it up for their own use.

An idea of the strength of these animals can be formed from the following instance. Near Chandesra village we were standing at the edge of a soap-stone quarry on the face of a hill. At the base of the hill there was a meadow fenced by Euphorbia with a mixed flock of sheep and goat grazing peacefully. Suddenly a wolf attacked a goat. There was great hullabaloo made by the graziers but the wolf carried the goat in its mouth and cleared the fence 5 ft high and $3\frac{3}{4}$ feet broad cleanly with the goat in its mouth. The men working in the quarry ran after the wolf creating a great din. Some right behind him and some took a short cut to intercept him on his way. After more than a Kilometre's chase the wolf dropped the prey and ran away. The dead goat was carried back triumphantly to the quarry. It weighed 7 kgs. and was eaten by the workers of the quarry.

I have not heard of any child lifting by wolves during the last 35 yrs. around Udaipur. Rabid wolves have been reported from this region. Leopards are very few in this region and they rarely prey upon goats and sheep, depending upon ailing and useless cows and bullocks which are left in the jungles unattended. Villagers seldom bother about such losses. The villagers are however worried by the depredation of wolves and try by every means in their power to destroy them but at present the wolves seem to own a charmed life. The villagers are searching for means to counter the threat posed by the wolves. If they succeed in turning the table the small population of these beautiful, courageous predator will be wiped out in a very short period.

41, Panchwati,
Udaipur-313 001,
December 6, 1986.

RAZA TEHSIN

5. ON A COLLECTION OF LONG-EARED BATS OF THE GENERA *OTONYCTERIS* PETERS AND *PLECOTUS* GEOFFROY (FAMILY: VESPERTILIONIDAE) FROM KASHMIR VALLEY

During the course of extensive collections of bats made by me in Kashmir Valley during the period 1976-1986, several specimens of long-eared bats were collected from Hari Parbat Hill, Shankaracharya Hill and adjacent areas in Srinagar city. On examination these were found to belong to the Vespertilionine genera *Plecotus* Geoffr. and *Otonycteris* Peters.

Otonycteris hemprichi Peters (Hemprich's Long-eared bat) is a remarkable bat which is an inhabitant of extremely barren and arid regions, whose distribution ranges from Kashmir and Russian Turkestan through Persia and Asia Minor to the Arabian peninsula. In North Africa it extends from Egypt through Libya to Tunisia and Algeria. Very little detail has been recorded of its habits in the region. Cheesman (1920) noted that this bat has been found in buildings but its natural habitat seems to be narrow crevices under overhanging stones in the sides of steep magmatic hills, as described earlier by Zahavi and Wahrman (1957). These findings are in conformity with mine, as all the specimens collected by me came from the steep sides of Shankaracharya Hill in Srinagar city.

Plecotus austriacus Fischer, the Grey Long-eared bat, is a cavern-dweller which inhabits tunnels in the flanks of barren mountains in Kashmir Valley. Specimens of this bat were collected from Hari Parbat Fort area at Srinagar. It has been previously recorded from northern and southern Israel. Aharoni (1930) noted it from the Dead Sea basin and Tristram (1866) from the Sea of Galilee. The precise range of the species has not been fully determined in relation to *P. auritus* Linn. It is found in Europe including Portugal, Spain, France, Italy, Czechoslovakia, Holland, Germany, Rumania, Austria, Yugoslavia, Corsica and Corfu, the Ukraine and probably the Caucasus, Transcaucasia, Armenia and Russian Turkestan, as well as Asia Minor. It is also known to occur in Persia, Afghanistan and the Arabian peninsula. It ranges to Egypt, N. Sudan, Cyrenaiea, probably south to Eritrea and Abyssinia and probably west to Tunisia, Algeria and the Canaries. Forms may be referable to this species extend eastwards to Siberia, China and Japan, but a good deal of research is needed before the specific affinities and distribution of the various described forms can be elucidated. It was first recognised as being present in England as recently as 1963 and its range in Britain is confined to a small area on the south coast of England (Burton 1982).

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6. UNUSUAL NEST SITE OF A THREE STRIPED PALM SQUIRREL, *FUNAMBULUS PALMARUM* AT POINT CALIMERE

On 28th November 1986, around 1410 hrs. we saw a three striped Palm squirrel carrying a young one in its mouth, under a Palmyra tree near our office campus. It was followed by another squirrel. The young one was held by its back and was slowly carried towards the Palmyra tree followed by the second adult. The squirrel climbed the tree with the other following when it reached the edge of the crown it waited there, within a minute the second squirrel climbed over the crown and started looking beneath. The young one was released and made to climb over the crown and to a leaf-stalk followed by the parent and both of them disappeared into the leaf fold. After this event the adult which was waiting below the crown rushed down to the ground and disappeared. After a few minutes, with the help of a local man who climbed the Palmyra tree, we confirmed the presence of the young one with one of its parents in the nest which was located on the leaf fold. This nest site is unusual and unrecorded before.

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7. A NOTE ON THE POST-PARTUM REPRODUCTION IN THE SHORT-TAILED BANDICOOT RAT (*NESOKIA INDICA*)

The occurrence of pregnancy during lactation and a lactation-controlled delay in blastocyst implantation in the rat and mouse have frequently been documented (Lamming 1978). In this, the female experiences a period of heat and even ovulates a few days after the parturition. If there is a successful mating during this period, the pregnancy may occur even when it is lactating. We have observed a few similar cases in the colony of the short-tailed bandicoot rat, *Nesokia indica*.

The rats were collected from the fields and were maintained in our animal house for experimental purposes. They breed successfully in captivity under natural photoperiod and temperature conditions and show breeding

activity during winter and spring months (Gariyali 1975). It was observed while breeding these rats that the female, kept with a male, delivered litters twice successively. Within the period of a single breeding season during 1984-85, three such cases of pregnancy were observed.

In first case, a single female rat was caged with one male for mating purpose. On December 10, 1984, this female delivered 4 young ones. On January 12, 1985, the same female again gave birth to 2 young ones. The time between the successive litters was 33 days. In second case, one female rat, kept with a male, littered 3 young ones on January 16, 1985. After a gap of 34 days, i.e. on February 19, 1985, this female gave birth to another litter of 2 young ones. And in third case, one female, kept with a male, delivered 4 young ones on March 19, 1985. On April 17, 1985, the same female littered another batch of 4 young ones. Twenty nine days intervened between these successive litters. In all these cases, the male was removed about 4-5 days after the first littering.

The observed second time pregnancy and then littering in the fore-mentioned cases may well possibly be due to a fertile post-partum mating within short time after the first parturition, as stated earlier. In first two cases, the time interval between the birth of the two litters are 33 and 34 days respectively which are more than the normal gestation period (av. 28.5 days) for the bandicoot rats. It is possible that the post-partum mating combined with delayed implantation of the blastocysts may account for these two cases. The incidence and duration of delayed implantation of blastocysts are known to be affected by the length and intensity of lactation (Lamming 1978). In third case, since the time interval between two litters is 29 days which is the normal gestation period of this animal, it is obvious that soon after the first littering a fertile post-partum mating and normal implantation of the blastocysts had occurred.

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8. ALBINISM IN THE BLUE BULL OR NILGAI, *BOSELAPHUS TRAGOCAMELUS* (PALLAS, 1766)

Albinism as a phenomenon of the lack of pigmentation resulting from the inability to synthetise melanin and caused by the absence of dominating allel is frequently observed among mammals of India, especially in such species as Chital or Axis deer — *Cervus axis* Erxleben, 1777, Blackbuck — *Antilope cervicapra* (Linnaeus, 1758), and Chinkara — *Gazella gazella bennetti* (Sykes, 1831). In specimens of these species bred in zoos of India —

chiefly in Ahmedabad — one can observe total albinism with red-coloured eyes. Albinism may be conditioned by the genes which at certain stage can slow down the production of melanin from tyrosine (Hutt 1972). Steinbacher (1951) takes into account a complete loss of melanin because of the genic split and he supposes that probability of the occurrence of individuals with albinism is increasing in the case when a couple is formed of a brother and sister because they are carriers of the recessive genes received by them from one of their parents. As a result of inbreeding white females of American tapir, *Tapirus terrestris* (Linnaeus, 1758) have been born in Poznan zoo as a result of the mating father and daughter (Smielowski 1979). Albinism in animals frequently occurs as a reaction of the organism to certain illnesses and injuries (Steinbacher 1951), to aging (Sokolowski 1962), unsuitable living conditions, overpopulation, and as a symptom of degeneration of a population (Ferens 1957). According to Hutt (1968) spontaneous depigmentation is probably hereditary, however its genetic and physiological basis are unknown. This phenomenon is similar to a premature greying of the hair in human beings (Hutt 1968). Similarly to a spontanous depigmentation the reasons if of a traumatic nature are also unknown. The effect of traumatic depigmentation is often observed in the birds whose heads have been pecked at by other birds. Perhaps the white spots on melanistic male of the black panther, *Panthera pardus* (Linnaeus, 1758) bred in Plock zoo from 24th August, 1969 to 7th February, 1984 are the result of a traumatic depigmentation, the same as observed in birds (Ptaszyk 1981). However, none of its numerous offsprings inherited depigmentation typical to their father.

The loss of a proper colour of the hair in mammals may result in hereditary changes, or it may have the character of nonhereditary acquired trait built as the result of disturbances in metabolism processes. Perhaps this brought about the disappearance of melanin synthesis, or caused its deficiency observed in a mature nilgai female, *Boselaphus tragocamelus* (Pallas, 1766) taken over from Amsterdam on 19th November 1975 and bred in Plock zoo since 21st April, 1979 (Smielowski 1980). The female has great, white spots on the neck and the trunk, particularly near the shoulder, buttock and on both sides of her body. Numerous, tiny white spots are also visible on the facial part of the head as well as on the upper parts of the hind and front limbs. The pattern of these spots has remained unchanged, despite of annual moulting in spring and in autumn. Since 1980 the female has had her regular offsprings, always twins. Despite her non-typical pigmentation she has always been the dominant in the herd, and also aggressive especially during the rearing of her progeny. Her offsprings have always normally coloured hair and part of them have been taken over by other zoos in the country (Lódz, Gdansk-Oliwa, Wroclaw). The young of this female are under continuous observation.

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9. MICROSCOPIC IDENTIFICATION OF FEATHERS AIDING BIRD HAZARD PREVENTION PROGRAMME IN INDIA

(*With two plates*)

The Bombay Natural History Society has since 1966, been receiving for identification, remnants of birds involved in bird-strike incidents in the Indian Air Force. The bird remnants sent are usually feathers picked up from the site of impact. Whenever the bird remnants were intact, such as a large complete feather, head or a foot, the species was conclusively identified while at other times, such as when the feathers were fragmentary or disfigured, the bird species could not be identified. In the earlier years bird remnants were identified at the BNHS by the then Research Assistant D. N. Mathew, and later on by Robert Grubh and others, to the extent possible under the then existing constraints.

However, with the launching of the Project "Ecological Study of Bird Hazards at Indian Aerodromes", funded by the Government of India in 1980, the BNHS investigated the possibility of identifying bird species even from a nondescript feather or a fragment. It was at this stage that RBG came across Brom & Buurma's (1979) and Brom's (1980) papers on microscopic identification of feathers. Brom's (1980) work was the first major contribution in this direction after the initial findings by Hargrave (1965) and Day (1966).

In 1982 October RBG spent a day at the Smithsonian Institution Natural History Museum (Bird section) with Roxie Laybourne who gave a detailed practical demonstration of the preparation of microscopic slides for identification of feathers.

The BNHS has adopted Brom & Buurma's method for feather identification since 1981. Using this method and the techniques (Ali and Grubh 1984 and Grubh and Ali 1984) we are able to narrow down the identification quite often to family or even generic level, further identification being effected by comparing with feathers of all species belonging to this genus or family from the BNHS reference collection. The research staff associated with feather identification since 1981 have been Lalitha Kupuswamy, Saraswathi Unnithan, S. M. Satheesan and the authors.

The Principle:

The microscopic structure of the feather barbules, particularly from the basel end of the vane, varies from one taxonomic group to another. The structural variations of barbules as explained by Brom (1984) are as follows:

1. Barbules may possess prongs.

2. Barbules are clearly subdivided into nodes and internodes (which are often pigmented).
3. Pigmented nodes can be heart-shaped, round or elongated and may have prongs of varying length.
4. Barbules show multiple nodes. The single nodes become loose and slide along the internodes to join the adjacent nodes. This process may be repeated till 8 to 10 nodes accumulate at one point.
5. Barbules may possess heart-shaped or round or elongated nodes only at the tips.
6. Nodes may decrease in size over a short distance.
7. Bases of barbules may possess villi (out growths).
8. The length of the barbules, the number of nodes as well as the internodal distance vary from group to group.

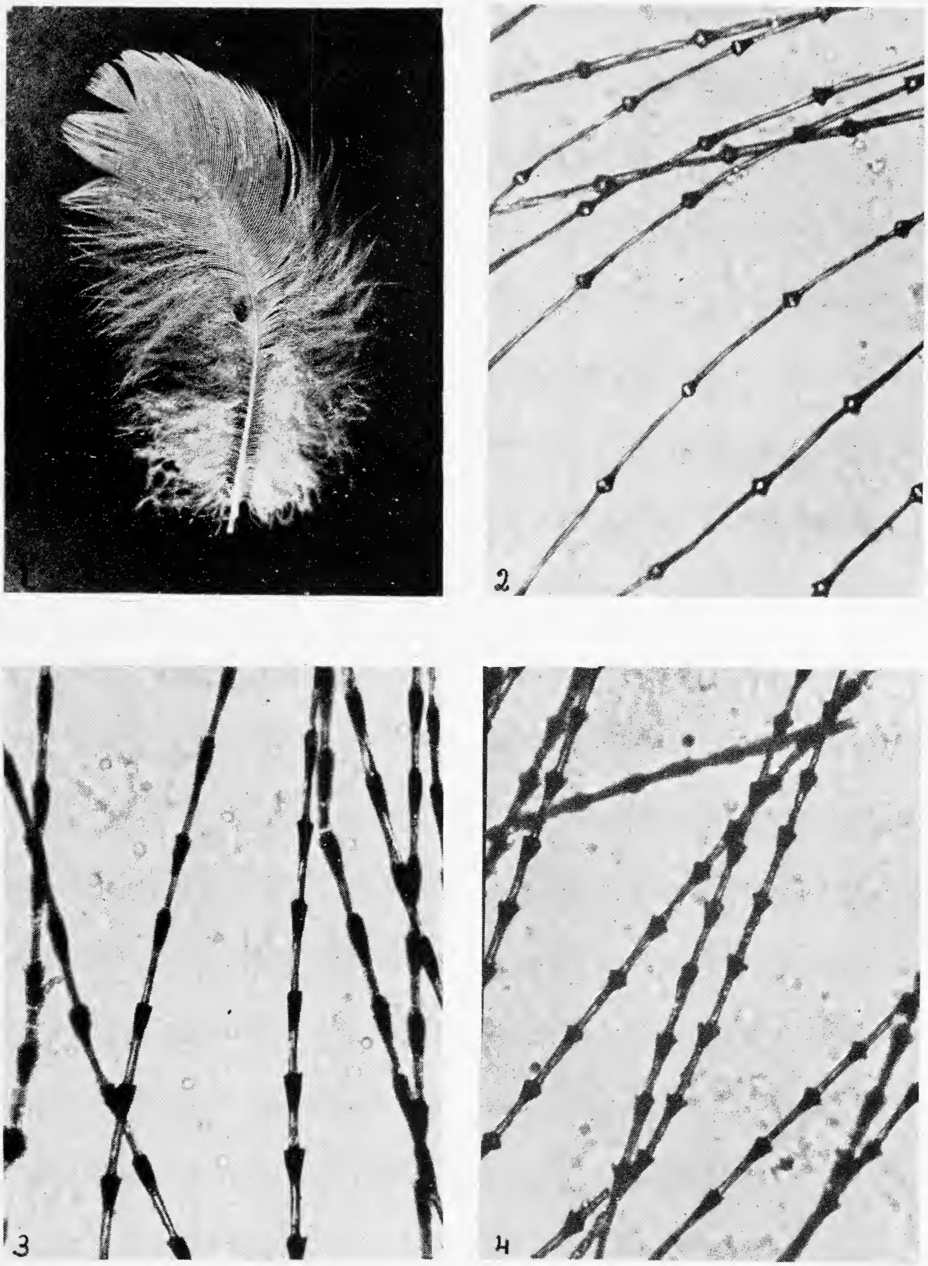
The photographs given here (see plates) show that it is possible to distinguish bird species from even a feather fragment (for detailed classification of bird taxa using this method see Brom (1980). So far the BNHS has identified almost all of the 125 odd bird remnants (having feather) sent to us for identification by IAF and the Civil Aviation. In all we have come across 46 bird species from these remnants (see Table 1).

Before the BNHS started identifying bird-strike remnants, one had to depend mostly on visual identifications made on the spot by

TABLE 1

BIRD SPECIES IDENTIFIED FROM BIRD STRIKE REMNANTS (N. 125)

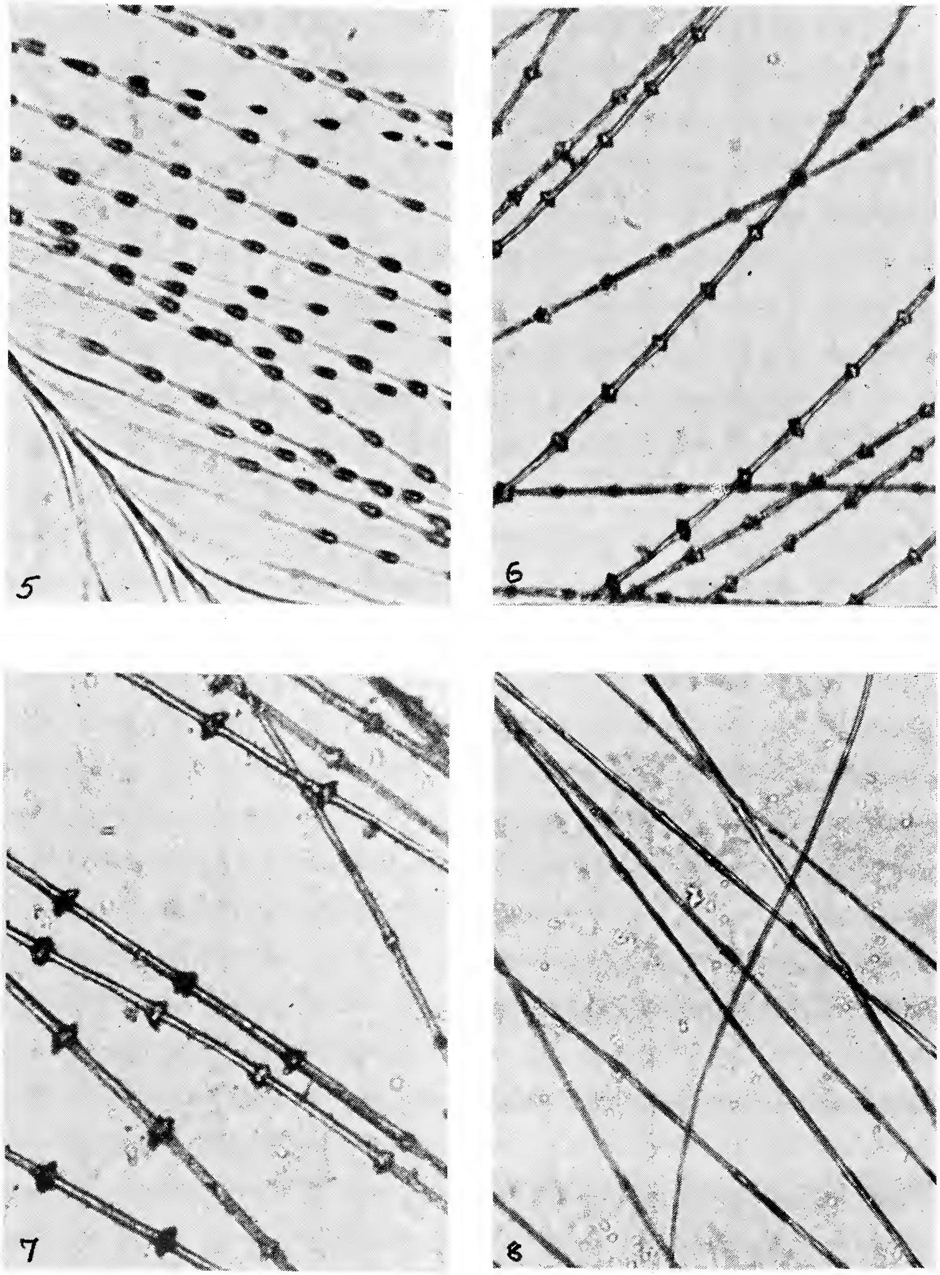
Species	Number of Remnant Samples
1. Pond Heron (*Ardeola grayii*)	1
2. Cattle Egret (*Bubulcus ibis*)	1
3. Blackwinged Kite (*Elanus caeruleus*)	1
4. Pariah Kite (*Milvus migrans*)	6
5. Brahminy Kite (*Haliastur indus*)	1
6. Longbilled Vulture (*Gyps indicus*)	6
7. Whitebacked Vulture (*Gyps bengalensis*)	29
8. Vulture (*Gyps* sp.)	4
9. Scavenger Vulture (*Neophron percnopterus*)	1
10. Hen Harrier (*Circus cyaneus*)	1
11. Short-toed Eagle (*Circaetus gallicus*)	2
12. Redheaded Merlin (*Falco chicquera*)	1
13. Kestrel (*Falco tinnunculus*)	1
14. Rain Quail (*Coturnix coromandelica*)	2
15. Painted Bush Quail (*Perdicula erythrorhyncha*)	1
16. Common Peafowl (*Pavo cristatus*)	3
17. Demoiselle Crane (*Anthropoides virgo*)	1
18. Stone Curlew (*Burhinus oedicnemus*)	1
19. Small Indian Pratincole (*Glareola lactea*)	1
20. Redwattled Lapwing (*Vanellus indicus*)	6
21. Yellow-wattled Lapwing (*Vanellus malabaricus*)	3
22. Sooty Tern (*Sterna fuscata*)	1
23. Indian Sandgrouse (*Pterocles exustus*)	1
24. Blue Rock Pigeon (*Columba livia*)	10
25. Indian Ring Dove (*Streptopelia decaocto*)	2
26. Spotted Dove (*Streptopelia chinensis*)	2
27. Little Brown Dove (*Streptopelia senegalensis*)	1
28. Roseringed Parakeet (*Psittacula krameri*)	1
29. Parakeet (*Psittacula* sp.)	1
30. Koel (*Eudynamys scolopacea*)	1
31. Swiftlet (*Collocalia* sp.)	1
32. House Swift (*Apus affinis*)	9
33. Palm Swift (*Cypsiurus parvus*)	4
34. Short-toed Lark (*Calandrella cinerea*)	2
35. Crested Lark (*Galerida cristata*)	1
36. House Swallow (*Hirundo tahitica*)	1
37. Indian Cliff Swallow (*Hirundo fluvicola*)	1
38. Redrumped Swallow (*Hirundo daurica*)	1
39. Rufousbacked Shrike (*Lanius schach*)	1
40. Starling (*Sturnus vulgaris*)	1
41. Common Myna (*Acridotheres tristis*)	1
42. House Crow (*Corvus splendens*)	4
43. Jungle crow (*Corvus macrorhynchos*)	1
44. House Sparrow (*Passer domesticus*)	1
45. Bat (Non bird) (*Pipistrellus mimus*)	2
46. Bat (Non bird) (*Taphozous* sp.)	1



1. A complete feather.

The following pictures are magnifications (1 × *c.* 300) of loose barbules from the base of the feather form different species.

2. *Psittacula krameri*; 3. *Otus scops*; 4. *Acridotheres tristis*.



The following pictures are magnifications (1 × *c.* 300) of loose barbules from the base of the feather from different species.

5. *Passer domesticus*; 6. *Streptopelia orientalis*; 7. *Columba livia*; 8. *Milvus migrans*.

pilots and other aviation officials. As a result the bird species supposed to have been involved in bird strikes were mostly restricted to very common birds and that too subject often to vague generalizations such as when names of 'eagles', 'vultures' and 'kites' were freely interchanged.

Correct identification of the bird species involved in a bird-strike incidents is essential for bird hazard prevention programmes using ecological methods. The most authentic way to recognise the bird species involved is to have the bird remnants positively identified by experts. Yet the extent of reporting of bird-strike incidents *along with bird remnants*, by civil aviation personnel in India, has been extremely unsatisfactory. The Indian Air Force, on the contrary is very keen to co-operate with us in our bird-hazard prevention programme. In fact over 90% of the bird-strike remnants we have received so far have been sent to us by the IAF.

ACKNOWLEDGEMENT

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10. GREAT CRESTED GREBE SIGHTING

Nagpur, city of oranges situated in the eastern tip of Maharashtra is surrounded by some of the most beautiful forests of our state. Outside Nagpur one of the lakes feeding the water supply to the city is the Ambhajhari lake. This lake is the residence of atleast two to three thousand Ducks and other waterfowl such as Coots, Teals, Pochards in winter. On Friday 13th December 1985 myself and fellow bird watchers Shri J. B. Kewate and Shri A. B. Gandhe saw two pairs of the Great Crested Grebe (*Podiceps cristatus*). They were also

sighted two days earlier. Their white facial and neck parts with prominent black top were carefully observed through binoculars by all three of us. They repeatedly dived for food. I believe this species is rare in our area and hence we would like to record its occurrence.

The same day and time we also observed a single Pied Harrier which was with us till almost 5.45 p.m.

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AMRUT DHANWATAY

11. ON THE CAPTURE OF WILSON'S STORM PETREL *OCEANITES OCEANICUS OCEANICUS* (KHUL) FROM THE SOUTH EAST COAST OF INDIA

During the fifth cruise on board FORV *Sagar Sampada* from Madras to Cochin in July, 1985 I caught two Wilson's Storm Petrels when they landed on the deck at dusk, probably attracted to the ship by the deck lights. When caught they did not make any attempt to escape due to failing light. They were active and pecked when the hand was taken near them.

The birds were of bulbul size with long slender legs with distinct yellow webbed toes. Colour of the birds was sooty black with a conspicuous white patch above the tail and pale wing bar. The beak was somewhat sharp with a small fleshy projection over it at the base.

According to Salim Ali and Ripley (1981) it is one of the most numerous bird species in the world. It breeds in Antarctic and Sub-antarctic Islands wandering north in the Atlantic, Pacific and Indian Oceans in summer, to Europe, Arabia, India, New Guinea, Japan, California etc. Not uncommon along the coast of the Persian Gulf, Makaran and Sind. It is also recorded from the Konkan coast and also from Bombay. Curiously enough it is not recorded from the northern parts of Bay of Bengal. It is now recorded from the South East Coast of India. They must have come from the Sri Lankan coast for they are known to visit Sri Lanka chiefly during the monsoon season.

I am most grateful to Dr. Sálim Ali for kindly identifying the bird.

Madras Research Centre
of CMFRI, Madras - 600 105,
December 28, 1985.

D. B. JAMES

Reference

Ali, Salim & Ripley, S. D. (1981): Handbook of the Birds of India and Pakistan. Vol. 1. Oxford University Press. 384 pp.

12. FIRST REPORT OF MASKED BOOBY, *SULA DACTYLATRA* FROM THE SHORES OF COASTAL KARNATAKA

(*With a photograph*)

On a quiet morning on July 1, 1985 at Katapadi, near Udupi (*c.* 13°23′N., 74°45′E), after a heavy rainfall the previous evening, the barking of dogs drew the attention of the local people to a strange bird. The bird was a rare one to our coast, a masked booby (*Sula dactylatra*).

Masked boobies are common throughout tropical oceans. Records show that there are colonies breeding in Cocos-Keeling, Barbados, Mauritius, Aldabra and in Maldive. They do not go far off from the oceanic land habitats, and hence are rarely to be seen on the coasts of mainland. Infact in India,

Photo. 1. Masked Booby (*Sula dactylatra*) caught at Mattu near Udupi on 1st July, 1985. (*Photo*: K. S. Harshvardhan Bhat).

it is said that there are hardly 4-5 reports so far on the occurrence of masked boobies on the west coast.

Ever since the report of the booby's arrival on July 1, 1985 appeared in newspapers, four more such boobies were spotted in different parts of coastal Karnataka within a range of 70 km. On July 3, a second booby was spotted at Trasi, 40 km north of Udupi but it was dead within two days of its arrival. At Panambur, about 35 km south of Udupi two more masked boobies were spotted during the second week of July, 1985, but could not be observed in detail as one had already disappeared (!) and the other was dead the very next day. On July 16, 1985, the fifth masked booby was found at Saligrama, 15 km north of Udupi. It was active but was too weak. The man who brought the bird said that a sum of rupees one hundred was offered for this bird for its exotic nature and delicacy. His refusal to sell it for money is appreciated.

Masked booby spotted at Katapadi was maintained for about two months by a fisherman, feeding it regularly with freshly caught fish. Mr S. A. Hussain of the Bombay Natural History Society helped us to ring this bird (ring No. K-421) and advised some flight exercises. In about two months the bird became healthy and active. In the meantime, the bird caught at Saligrama was also kept with the previous one and was also ringed (K-422).

Both the boobies were let off from Coconut Island, the northernmost island in the group of islands known as St. Mary's Islands, during October 1985. The birds took to wing happily and went out of sight. However, the bird carrying ring K-422 was found on the shore of Malpe near Udupi, and in a couple of days it died.

The unusual appearance of the boobies along the 70 km of west coast of Karnataka, almost simultaneously, posed a number of questions. Was there a large flock of boobies that moved along the west coast during July this year? If so, what prompted them to do so? Interestingly, all the birds that were spotted, were too weak and could not take to wing on their own. This might mean that only the exhausted and weak ones must have stayed while the rest must have moved away. But where? Or, was there any cyclonic or other turbulence in the Indian ocean or the Arabian Sea which drove some of these birds ashore? Could it also mean that some of them had lost their way and landed on our shore?

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UDUPI 576 101,
December 27, 1985.

13. THE GOSHAWK, *ACCIPITER GENTILIS* (LINNE) IN POONA, MAHARASHTRA

Southwest of Poona city is the National Defence Academy at Khadakwasala. The approach road to this passes over moderately sloping hills covered with bushes and trees. Close to the establishment, the vegetation turns into a dry deciduous type of forest that is protected as a sanctuary.

On October 18, 1981, we saw a large hawk dive steeply and land on a leafless tree on the top of a hill some distance away from the

road. Keeping under cover we cautiously approached the bird and were able to get a very clear view of it. A white supercilium stood out well against the grey head. The underparts were barred dark grey while the back was grey and the tail being fairly long had dark bars on it. The bird was identified as an adult Goshawk, *Accipiter gentilis* and judging from the size it was a female. As we edged forward to get a closer look, the bird flew off fast. Some days later, on November 4, 1981 we saw a single bird in the same area again.

On October 22, 1981 we saw one bird again in the Baner area west of Poona. As the distance between the three sightings is only a few kilometres, it seems possible that the same individual was seen each time.

The Goshawk is a rare winter visitor to the lower Himalayas and has been recorded in Sind, Bahawalpur and Saurashtra (Ripley 1982). Dharmakumarsinhji (1955) describes the bird being seen once in the winter of 1948 in the Gir forest and the capture of an immature female in the month of December in Bhavnagar, Gujarat. He records it once from Mt. Abu in Rajasthan. Our sightings constitute a record of this species for Maharashtra and an extension of its known range south of Gujarat.

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14. ON THE IDENTIFICATION OF SOME INDIAN BUZZARDS

Introduction

Identification of museum specimens of the genus *Buteo* can be a rather complicated issue, because of the great individual and geographic variation: in the plumage coloration (the birds occur in reddish, brownish and blackish colours in varying degrees of lightness), and in morphometric measurements (bill, wings, tarsus and tail), which shows proportional as well as dimensional differences.

Interspecific variation occurs in both plumage-coloration and morphometric characters. Intraspecific variation expresses itself in size

differences between sexes (female larger than males), in differences between age groups (younger individuals are lighter than older ones), and in differences between individuals from different geographic areas.

As Indian Buzzards never have been investigated with this in mind, one can have some difficulties in identifying the different species and subspecies from each other. Therefore, H. Abdulali, during his reidentification of the specimens in the collection of Bombay Museum of Natural History, sent me some "difficult" Buzzards for identification, and asked if I was willing to write a note of how to identify Indian Buzzards.

I have chosen only to treat the four species and subspecies which cause great confusion namely: *Buteo rufinus, Buteo hemilasius, Buteo buteo vulpinus* and *Buteo buteo japonicus.* From those handbooks and original papers, which were available to me (see the references), I have collected data, and to this information I have added measurements from the rather few specimens from Zoological Museum in Copenhagen, and from Bombay.

This note does not deal with the general biology, but these can referred to in the handbooks and original papers (some are quoted under the references).

The Tables

The tables are structured so that they can be used as a kind of "identification key", and for each table, the taxa are arranged according to increasing size.

According to the wing measurements (Table 1), there can be some problems in separating the two subspecies *B. b. vulpinus* and *B. b. japonicus* from each other. *B. b. vulpinus* is slightly smaller than *B. b. japonicus,* — and in this case one can relatively safely rely on the fact, that the plumage of *B. b. vulpinus* appears more reddish than that of *B. b. japonicus.* Separated on wing measurements *B. rufinus* and *B. hemilasius* can hardly be confused.

Information on bill measurements (Table 2) is very scattered. Besides, in the case where the authors have mentioned how they have measured the bills, it was in two different ways: some have included the cere, and some have excluded the cere.

Concerning the tarsus measurements (Table 3), one must be aware of the general difficulties in measuring this character accurately on museum specimens. Apparently only *B. hemilasius* can be identified with certainty, while the others are very similar in size according to this character.

The four species and subspecies are easily separated, when one uses the tail measurements (Table 4).

Comments on the tables

From handbooks and original papers concerning Indian Buzzard's plumage coloration, I cannot point out one particular description, which is especially good and exact, — but for subjective descriptions I can refer to the literature quoted here. In order to obtain an objective determination of the colour variation spectrophotometry is recommended (Dyck 1966). Patterns and coloration in the plumage of the Buzzards are therefore not referred to in detail in this note. Concerning the information obtained from handbooks, the median and ranges given, suggest that some of the authors have used identical sources. Therefore, the actual number of specimens investigated for each of the four taxons may be smaller than that given in the tables.

Moreover, in some instances sample sizes are not given. If there exist any kind of clinal variation, it is not taken into account, because

TABLE 1

WING MEASUREMENTS OF *Buteo buteo vulpinus*, *Buteo buteo japonicus*, *Buteo rufinus* AND *Buteo hemilasius*.

	♂			♀			Sex unknown			
Species	n.	Range	Average	n.	Range	Average	n.	Range	Average	Author
B. b. vulpinus	—	350–385	367.5	—	350–390	370				23
	—	350–377	363.5	—	378–392	385				5
	—	350–385	367.5	—	350–390	370				4
	82	342–372	357	77	360–386	373				12
	27	341–387	364	21	352–400	376				10
	21	343–370	356.5	13	358–383	370.5				20
				1		367	3	359–380	369.5	Bombay
B. b. japonicus	—	374–379	376.5	—	389–454	421.5				5
				1		348				2
	2	367–371	369	1		422	1		400	3
	—	374–379	376.5	—	389–454	421.5				4
	14	365–388	376.5	20	378–426	402				12
	13	362–400	381	11	370–408	389				20
B. rufinus	—	415–431	423	—	428–458	443				5
	1		438							3
	—	415–431	423	—	428–458	443				4
	24	405–438	421.5	24	442–475	458.5				12
	19	425–459	442	18	448–496	472				10
	1		408				1		432	Bombay
	7	432–449	440.5	10	434–485	459.5	1		434	ZM.
B. hemilasius							—	480–501	490.5	5
							—	480–501	490.5	4
	2	465–475	470							Bombay
							1		454	ZM.

ZM.: ZOOLOGICAL MUSEUM, COPENHAGEN.

TABLE 2

BILL MEASUREMENTS OF *Buteo buteo vulpinus*, *Buteo rufinus*, *Buteo buteo japonicus* AND *Buteo hemilasius*.

	♂			♀			Sex unknown			
Species	n.	Range	Average	n.	Range	Average	n.	Range	Average	Author
B. b. vulpinus	—	20–23*	21.5							23
	—	20–23*	21.5							4
	27	18.8–22***	20.4	21	19.2–24.1***	21.65				10
B. rufinus	—	32–34**	33							4
	20	23.6–29.2***	26.4	20	25.9–31.9***	28.9				10
	6	23.7–29.9*	26.7	10	25.1–30.1*	27.6	1		24.9*	ZM.
B. b. japonicus	1		30***							2
	—		29***	—	29–36**	32.5				4
B. hemilasius							—	34–36**	35	4
							1		26.4*	ZM.

*: Bill measurements excl. cere, **: Bill measurements incl. cere.
***: Not mentioned how the bill is measured.
ZM.: Zoological Museum, Copenhagen.

TABLE 3

TARSUS MEASUREMENTS OF *Buteo buteo vulpinus, Buteo buteo japonicus, Buteo rufinus* AND *Buteo hemilasius*

	♂			♀			Sex unknown			
Species	n.	Range	Average	n.	Range	Average	n.	Range	Average	Author
B. b. vulpinus	—	65–75	70							23
	—	68–72	70	—	68–73	70.5				5
	—	65–75	70							4
	14	70–75	72.5	13	71–79	75				10
				1		57	3	44–64.5	54.25	Bombay
B. b. japonicus	—	63–65	64	—	69–74	71.5				5
				1		75				2
	—	63–65	64	—	69–74	71.5				4
B. rufinus	—	56–82	69	—	60–77	63.5				5
	—	56–82	69	—	60–77	63.5				4
	22	85–93	89	23	87–94	90.5				10
	1		80				1		67	Bombay
B. hemilasius	—	81–90	85.5							5
	—	81–90	85.5							4
	2	74–83	78.5							Bombay

TABLE 4

TAIL MEASUREMENTS OF *Buteo buteo vulpinus, Buteo buteo japonicus, Buteo rufinus* AND *Buteo hemilasius.*

	♂			♀			Sex unknown			
Species	n.	Range	Average	n.	Range	Average	n.	Range	Average	Author
B. b. vulpinus	—	175–195	185							23
	—	180–191	185.5	—	182–201	191.5				5
	—	175–195	185							4
	28	174–207	190.5	19	178–210	194				10
				1		198	2	192–207	199.5	Bombay
B. b. japonicus	—	198–209	203.5	—	225–248	236.5				5
	—	198–209	203.5	—	225–248	236.5				4
				1		188.5				2
B. rufinus	—	228–250	239	—	230–257	243.5				5
	1		242							3
	—	228–250	239	—	230–257	243.5				4
	20	207–244	225.5	20	223–262	242.5				10
	1		232	1		225				Bombay
B. hemilasius	—	255–282	270							5
							—	255–282	270	4
				2	235–240	237.5				Bombay

the exact nature of such clines is not known for Buzzards from this area.

According to these four tables it is obvious, that it is not enough only to use one character in the identification process. Primarily, because of the heterogenity of the data in the tables, — and secondly because of the size differences (e.g. female larger than males; *B. hemilasius* larger than *B. b. vulpinus*), and the proportional differences (e.g. *B. rufinus* with relatively small bill in relation to wing, tarsus, bill and tail measurements). But if one uses at least these four characters *in combination*, it should be relatively safe to identify specimens belonging to the four species and subspecies in question.

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15. THE SANDWICH TERN (*STERNA SANDVICENSIS*) IN SRI LANKA

During almost 6 weeks, from the 16th February to the 28th of March, 1986, I was able to observe every day several Sandwich Terns, varying in number from 1 to 6. These birds were resting throughout most of the day on two rocks in the sea about 200 yards off the coast at Colombo, south of the Lighthouse. These rocks are habitually used during the late North-East Monsoon and the intermonsoonal season up to about May by various species of Terns, notably Large Crested Terns (*Sterna bergii*), Lesser Crested Terns (*Sterna bengalensis*), always few in number, Whiskered Terns (*Chlidonias hybrida*), Common Terns (*Sterna hirundo*) in varying numbers, intermittently by Little Terns (*Sterna albifrons*), and occasionally White-winged Black Terns (*Chlidonias leucopterus*). As I live nearby on top of a 5-storey building, I have excellent opportunities of watching these birds through binoculars and by means of an Optolyth 30 × 75 telescope. I have indulged in this pastime over a number of years and have, for instance, been able to show that the Common Tern is by no means as rare or irregular a visitor to the Colombo coast as had been assumed; most of the Common Terns seen here are first and second year birds. Incidentally, I also discovered a breeding colony of this Tern on a small island composed entirely of coral debris about a mile off the east coast near Mankerni in May 1980 (see Ceylon Bird Club Notes, May 1980, p. 27-29, June, p. 31-32, July, p. 39-40, and August, p. 43).

Except for one, the up to 6 Sandwich Terns which I observed at Colombo were first or second year birds. Their identity was established beyond any doubt on the basis of the clearly visible yellow tip of the bill as well as other characteristic features. Their behaviour on the rock was very much the same as that of the other Terns. During the first half of the day from about 9 a.m. onwards, they would sit and preen themselves, occasionally jostling for position, taking off and coming back when disturbed by House Crows (*Corvus splendens*), rarely feeding on nearby shoals of sardines. All the Terns are easily put to flight by the approach of a single Crow; Crows make it a habit to do this at frequent intervals and even chase some Terns, apparently for sheer mischief. I have even noted the Terns to take to the air with the approach of a White-breasted Kingfisher (*Halcyon smyrnensis*) and when a Brahminy Kite (*Haliastur indus*) soared high above. They all are very timid birds despite the formidable looking bills and never resist the intruders into their domain. In the afternoons the Terns just sit, always looking in the direction of the wind, often with beaks open. The one Sandwich Tern noticed on 21st February was in Summer plumage, with fully developed black cap, whereas the others showed the black and white speckled sides of the crown, typical of immatures throughout the period they were here. I have not seen any Sandwich Terns since the 28th of March and assume that they would have started on their return migration, presumably to the Black Sea area. The Common and Lesser Crested Terns disappeared soon afterwards.

According to the HANDBOOK (Vol. 3, p. 70) the Sandwich Tern is a winter visitor in fair numbers to West Pakistan, but there is only one sight record in India from Gujarat in 1958. In the latest issue of the *Journal* of the BNHS (Vol. 82, No. 2, August 1985, p. 410) there is a note of a record of a ring recovery

from the Ernakulam District in Kerala in March 1976. The bird had been ringed as a juvenile the year before (on 26.6.75) at the Krasnovodsk Reserve, Krasnovodsk Gulf, Caspian Sea, Turkmenian SSR. It is noted that the publication came 9 years after the recovery! The author states that no specimen has so far been collected in India and that there are no recent sight records of this species.

In December 1977 a ring from a Sandwich Tern was recovered at Kalpitiya, Sri Lanka. This bird had been ringed on 27.7.77 as a juvenile in the Astrakhan Reserve, which is a small island in the Northern part of the Caspian Sea, USSR. This was the first record and evidence of the presence of the Sandwich Tern in Sri Lanka, which was followed by sight records as below:

1 at Talaimannar	..	21.9.78
2 at Negombo	..	4.11.78
10 at Talaimannar	..	5.10.79
1 at Talaimannar	..	3.2.80
1 at Colombo	..	10.2.80
1 at Point Pedro	..	23.2.81

The present observation of up to 6 Sandwich Terns for a period of nearly 6 weeks at Colombo is the first record of the presence in Sri Lanka of this species for a period of time and clearly indicates that it is in the process of extending its winter range very substantially and in some numbers. It is possible, even probable, that the birds were in Sri Lanka, if not at Colombo, throughout the winter; they were not noted by me earlier as my observations of the rock were quite sporadic till then. The presence of an adult bird in Summer plumage on 21.2 on only that day indicates that the wintering birds are moving around along the Sri Lankan coasts, but most seem to be immatures.

Amongst the other Terns the Sandwich Tern is easy to distinguish (yellow tip of bill) with good binoculars if one is close enough, or with a telescope, as in my case, but obviously not if these amenities are lacking. In size the Sandwich Tern is between the Large Crested and the Lesser Crested, but it is distinguished from both by being much whiter, which is particularly noticeable in flight. Once I had become aware of the presence of the Sandwich Terns, I could pick them out sitting amongst the others with the naked eye from a distance of over 500 metres merely on the basis of the characteristics of size and whiteness. I cannot see how the Sandwich Tern can be confused with the Gull-billed Tern (*Gelochelidon nilotica*) although both are of similar size and coloration, but apart from this they are different in shape and particularly in the size and form of the bill which is much more pointed and much longer in the Sandwich Tern; even the small crest is noticeable in the silhouette which is much more like that of a Crested Tern than that of a Gull-billed Tern. I have never seen the latter on the Colombo coast, though they are plentiful inland during the winter season.

From about December or January to May Terns of the species listed above can be seen on these particular rocks at Colombo which affords excellent opportunities for studying moulting patterns and changes in the coloration of the bill, feet, etc., because during this period all the species change over to Summer plumage. At the moment all the Large Crested and most of the Whiskered and Little Terns are in breeding plumage. In earlier years before the onset of the SW Monsoon when they all disappear, I have

often observed prenuptial display by Large Crested Terns, with ritualised offering of small fish to females (e.g. Ceylon Bird Club Notes, April 1978, p. 25). On 20.4.86 I noted 2 instances of mating and one offering of a small fish which was accepted.

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P.S.: "Since writing the above (or foregoing) I have naturally been on the lookout for Sandwich Terns this season as well. The first bird appeared on 18th January amongst 60 Large Crested Terns and about 20 Lesser Crested Terns. Subsequently the number increased to 3, which I continue to observe daily. I except them to leave around mid-March like last year". (27-2-1987).

16. KASHMIR ROLLER (*CORACIAS GARRULUS* LINNAEUS) IN RANEBENNUR, KARNATAKA

On 30 September 1984, we were returning to the Forest Rest House at Ranebennur (14°37′N, 75°32′E) at about 0945 hrs, after sighting a male Great Indian Bustard (*Choriotis nigriceps*) close to the Hullati Block of the Ranebennur Blackbuck Sanctuary in Karnataka. We had walked across the undulating grassy and gravelly terrain that stretched for over 1 km from the Hullati Block and were approaching a vast field of jowar (*Sorghum bicolor*) when we sighted a Kashmir Roller (*Coracias garrulus* Linnaeus) perched on a high branch projecting from a 2m tall *Prosopis juliflora* hedge that bordered the jowar field.

The pale bluish-green head, neck, breast and rest of the underparts and the pale chestnut upperparts drew our attention to it. The bird was not shy and permitted a close approach. One of us (RV), could get to within 4 m of the bird. Twice we put the bird to flight and it returned to a perch within 6 m from the previous perch. In flight its wings clearly lacked the contrasting dark and light blue bands, and the rufous-brown breast of the Indian Roller (*C. benghalensis*) which was very common in the dry environs of Ranebennur.

The Kashmir Roller is known to breed in the N. W. Frontier of Pakistan, the Gilgit and in Kashmir. It migrates to Arabia and presumably to Africa in the autumn, commonly passing through Sind, Rajasthan and Northern Gujarat (Kutch and Saurashtra) (Ali and Ripley, 1970: 114). Stragglers are recorded as far east as Seoni District in Madhya Pradesh (Lakhnadon, 79°30′E) and south through Maharashtra (Dhulia, Khandala and Bombay) (Ali and Ripley, 1970: 114). Davidson (1898)

shot a single specimen of this species in November 1893, at Majali, five miles north of Karwar (14°50′N) and since then, the species has never been recorded anywhere in Karnataka. In view of the above, our present sighting of this bird in Karnataka after a gap of over nine decades happens to be the recent and the southernmost record for the species.

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17. AN INTERESTING FEEDING BEHAVIOUR OF THE WHITECHEEKED NUTHATCH (*SITTA LEUCOPSIS*)

In May-June 1985 I stayed in Overa Wildlife sanctuary near Pahalgam, Kashmir, to study the genus *Phylloscopus* (leaf warblers) with Dr. T. D. Price. On 16th May I visited Kanjkut, an open meadow surrounded by coniferous forest. At this place coniferous forest ends and gives way to silver birch. Here I found 3 pairs of the Whitecheeked Nuthatch (*Sitta leucopsis*), frequenting dry and bare coniferous tres. The birds were very noisy calling with their distinctive, loud nasal calls. I spent an hour watching them and to my surprise they all fed by flycatching, in the manner of the Sooty flycatcher (*Miuscicapa sibirica*), fluttering out to hawk insects. The birds were flying clumsily, straight towards the insect sometimes as far as 60 ft and returning to almost the same perch. The birds called loudly while in flight and also when at rest. Courtship feeding was observed twice. The nuthatch predominatly fed in the fly-catcher manner, and their normal method of creeping amongst the branches was rarely noticed. All the birds frequently perched crosswise on the branches.

Later, in the first week of June, we moved our camp in this locality, and then also I observed this behaviour often. The common factors in all these observations were; strong sunlight and dry coniferous trees in the open. The nuthatches were also common in forest at lower elevations but I never noticed this behaviour there.

This flycatcher-like feeding habit does not seem to have been recorded for the Whitecheeked nuthatch and possibly not for any other species of nuthatch within Indian limits, and is worth placing on record.

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18. MUNIAS AS FACULTATIVE NEST PARASITES

Common silverbill or whitethroated munia (*Lonchura malabarica*) habitually utilises old nests of the baya (*Ploceus philippinus*) for laying eggs (HANDBOOK Vol. 10 — Ali and Ripley). I have been watching whitethroated munia along with other munias since 1981 at Tatar Pur (27°47′N, 76°31′E), Alwar District, Rajasthan utilizing the old nests of baya as a facultative nest parasite. I have frequently seen whitethroated munia utilizing old nests of *Ploceus benghalensis* also.

In addition I have seen 3 pairs of spotted munia (*Lonchura punctulata*) utilizing the old nests of *Ploceus philippinus* for breeding on dense (*Acacia tortilis*) trees in Panchayat Land Plantations at Tatar Pur in August 1983 and September 1984.

During August 1984 when I was going to inspect a *Ploceus philippinus* colony in Tatar Pur Mixed Plantation, I saw a Red Munia (*Estrilda amandava*) sitting on the chinstrap inside a half built baya nest. This year, on 16th July 1985 I again saw a Red Munia hovering around a completed nest of *Ploceus philippinus* in the same locality. Though I have seen red munia twice inside or around baya nests, I have so far not come across the bird actually nesting within.

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19. ADDITIONS TO THE HERPETOFAUNA OF CHILKA LAGOON, ORISSA

No research is reported on the herpetofauna of the Chilka lagoon, Orissa since the pioneering investigations by Annandale (1915) probably because Indian herpetologists have thus far paid little attention to the estuaries. However, the on-going multidisciplinary project taken up by the Estuarine Biological Station of the Zoological Survey of India located at Berhampore has generated an upsurge of interest in the herpetofauna of the lake's Islands, hills, and shores with the result that quite a few lizards and snakes are recorded as additions to the faunal list of the area under study.

In the course of the third expedition to the lake conducted during December 1986 the authors were pleasantly surprised to find a colony of the Dwarf Rock-Lizard *Psammophilus blanfordanus* in the Ghantasila Hill and on the Bird Island situated not far from Rambha. Some of the individuals which we saw were adults (195 mm) in breeding colour, with swollen and scarlet-red cheeks. We were equally surprised to find the presence of the Beaked Sea Snake *Enhydrina schistosa,* a juvenile (750 mm) and an adult (1093 mm) of which were picked up from the fishing nets operated in the midwaters of the lake off Rambha and Barkul. Although Malcolm Smith (1943) made no mention of the likelihood of the occurrence of this species in estuaries and Annandale (loc. cit.) failed to record it from the Chilka lake, the fact that the Beaked Sea

Snake frequents the estuaries is established beyond doubt (Murthy 1977). Local fishermen call the Beaked Sea Snake 'Dushta Sarp' which in Oriya means a very bad snake, indicating the fear for the snake's deadly venom and its toxicity. Another noteworthy record made in the same trip is that of the Smooth Water Snake *Enhydris enhydris,* a juvenile (450 mm) of which was picked up from the shallow waters of the lake at Ghodedowda village.

It may therefore be concluded that the specimens of the Dwarf Rock-Lizard, the Beaked Sea Snake, and the Smooth Water Snake are not only additions but also the first documented records from the Chilka lagoon.

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20. RETENTION OF EGGS BY THE EMYDINE TURTLES *KACHUGA TECTUM TECTUM* AND *KACHUGA SMITHI*

Turtles are known to have a tendency to retain eggs either in the oviduct, cloacal bursa or in the abdominal cavity (Risley 1933, Cagle 1944, Cagle and Tihen 1948, Duda and Gupta 1978). The retention has been attributed to unfavourable weather conditions or lack of proper facilities for egg laying during laying season.

On 22.4.1977, a specimen of *Kachuga tectum tectum* was noted to have a shelled egg inside its highly distended right cloacal bursa. The ovary looked spent and showed the presence of 11 ruptured follicles, 7 in the right and 4 in the left, all of which were at nearly the same stage of differentiation into corpora lutea. The oviducts were fully developed but, did not show any eggs within. In weight and measurements and external and internal features, the turtle looked a healthy normal female.

Judged from the number of the ruptured follicles in the two ovaries, the turtle had

obviously ovulated 11 eggs but laid only 10, the odd one having pushed its way into the cloacal bursa and got stranded here. The egg was 38 mm in its longest axis and 21 mm in its maximum girth, which compared favourably with normal eggs of the species. Additionally, a lot of intestinal debris had filled the cloacal bursa containing the egg. The left side cloacal bursa was, however, in a collapsed state and did not contain any filling material.

The finding of an egg inside the right cloacal bursa, in *Kachuga tectum tectum*, is almost identical to Dobie's (1968) finding of eggs in the urinary bladder in turtle, *Macroclemys temmincki*. He attributed such abnormal position of eggs in his turtle to some carapaceal deformity and consequent crowding of reproductive structure. In the *Kachuga tectum tectum*, on the contrary, carapace, orientation and spacing of internal viscera was normal and, therefore, could not have contributed to the wrong channelling of the egg into the cloacal bursa, nor could it be attributed to unusual simultaneous movement of two eggs from opposite oviducts into the cloaca leading to overcrowding. It appears that the presence of shelled eggs in any unorthodox situation is just a matter of accident.

While in a mature female of *Kachuga smithi*, a shelled egg (37 × 22 mm) was found present in the right oviduct, collected on April 4, 1978. No Corpora lutea, fresh or old were to be found in its ovaries.

Retention of a single egg in the oviduct of *Kachuga smithi* in the month of April, speaks for unseasonal presence and irregular deposition, because in this species the normal months of laying are from late August to the middle of November and clutch size ranges from 3 to 11 (Gupta 1979). Irregular deposition of eggs in turtles is already in record (Miller 1932) who reported about a gopher turtle that deposited egg on October 4, another on 7th, 2 on 8th, and 5th on the 30th of October. He contributed this irregular deposition to the unsatisfactory condition for laying. Additionally the retention of a soliary egg in the oviduct without any trace of corpora lutea in the ovaries may also indicate that the retained egg is a laggard which has failed to get deposited alongwith other members of its clutch. The last clutch has apparently oviposited quite sometime back sufficiently early to let all the corpora lutea to heal up. This odd observation may turn out to be an important one, because it tends to conflict with functional relationship between the Corpus luteum and the maintenance of eggs inside the oviduct.

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21. TURTLES USING DOMESTIC BUFFALOES AS BASKING RAFTS

(*With a photograph*)

While on a trip to Zainabad to see the Wild Ass last summer I was staying with Shri Shabir Malik. In front of his home there is a small tank that is used for washing clothes, buffaloes and cattle.

On the first day while photographing sand-grouse that frequent the tank, I saw a herd of buffaloes being driven into the water.

As soon as they had submerged themselves I noticed a turtle clamber onto a buffalo's back! No sooner had I taken a picture of this curious relationship, I saw another two clamber onto the back of another buffalo.

Photo. 1. Turtle basking on buffalo back.

I observed this association between buffalo and turtle on all the three days that I was at Zainabad. On one visit I counted nine turtles basking on their huge mobile islands. I do not recall seeing a single turtle basking on the edge of the tank throughout my visit. The turtles seemed to be waiting for their basking steeds to arrive, so that they could bask undisturbed.

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22. A NOTE ON THE BREEDING OF ESTUARINE CROCODILE (*CROCODYLUS POROSUS*, SCHNEIDER) AT NANDANKANAN BIOLOGICAL PARK, ORISSA

A lone female estuarine crocodile (*Crocodylus porosus*) which has been laying infertile eggs since 1975 at Nandankanan Biological Park, Orissa (Acharjyo and Mishra 1981) was paired with an adult male of the same species procured from Crocodile Research Centre, Kukrail (Uttar Pradesh) from April 1, 1983. Both of them were put together in a specially built breeding pool having a capacity of holding approximately 8,26,000 litres of water and with a depth of 2 metres. The land area of the pool complex is about 1500 square metres. There is a compound wall of 2.1 metres high all around except over a length of 23 metres on the viewer's side. There is provision of filling this pool with fresh water and wetting the surrounding land area at regular intervals. The pool complex has been suitably planted with some local and mangrove vegetation. The details of egg laying from 1975 to 1986 are given in Table 1.

TABLE 1

Year	Date of egg laying	Number of eggs laid	Remarks
1975	30 May 1975	29	Infertile eggs
1976	4 June 1976	34	Infertile eggs
1977	2 June 1977	35	Infertile eggs
1978	22 May 1978	34	Infertile eggs
1979	No eggs were laid		
1980	16 June 1980	34	Infertile eggs
1981	No eggs were laid		
1982	15 June 1982	33	Infertile eggs
1983	No eggs were laid		
1984	26 April 1984	22	Infertile eggs
1985	15 April 1985	16	Fertile eggs
1986	18 April 1986	21	Fertile eggs

The eggs were laid during the three month period, April-June and the clutch size varied from 16 to 35 eggs (mean 28.67). Though the egg laying was an annual feature from 1975 to 1978 and again from 1984 to 1986, the egg laying was on alternate years from 1979 to 1983.

The eggs were laid inside a mound nest consisting of dried leaves, twigs, sticks, soil etc. collected from inside the pool complex. The nests of 1985 and 1986 measured 125 × 135 cm., height 45 cm and 145 × 155 cm, structed underneath a tree at a distance of height 50 cm respectively. The nests were con- about 10 metres from the edge of the pool. The eggs were white and hard shelled. Five infertile eggs of 1985 measured 7.1-7.8 × 4.1-4.6 cm. The mother used to zealously guard the nest from a dug out wallow near the nest

as described earlier by Acharjyo and Mishra (1981).

The details of hatching of eggs laid during 1985 and 1986 are given in Table 2.

TABLE 2

Date of egg laying	Number of eggs laid	Dates of hatching	Number hatched	Incubation period in days	Percentage of hatching
15 April 1985	16	5&6 July 1985	11	82-83	68.75
18 April 1986	21	30 June & 1 July 1986	9	74-75	42.86

Eight newly hatched hatchlings of 1985 measured 28.5-30 cm (mean 29.01 cm) and weighed 55-75 grams (mean 69.63 gm).

This species has been bred in captivity at Higashi Izu zoo, Japan; Singapore zoo and Djakarta zoo (Bustard 1980), at Melbourne zoo (Dunn 1981) and at Madras crocodile Bank (Whitaker, pers. comm.). Earlier workers (Acharjyo and Mishra 1981, Choudhury and Bustard 1979, Daniel 1983, Dunn 1981, Groombridge 1982, Smith 1931, Webb *et al.* 1977, Yangprapakoran 1971) have reported on different aspects of reproductive behaviour of this species both in captivity and free living state.

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23. FOOD OF THE COMMON SKINK *MABUYA CARINATA* (SCHNEIDER)

On 22nd October 1986, while waching the activities of the common house swift behind the Baroda museum at 10.00 A.M. I saw a large specimen of the Common Skink (*Mabuya carinata*) moving around a small bush, about five feet from me. I think that the skink was searching for insects. A juvenile Garden Lizard (*Calotes versicolor*) was basking on a branch about 30 cm from the ground on the same bush. The skink and the calotes, saw each other. Suddenly the skink tried to climb on to the branch of the bush, on which the calotes was seated. The frightened calotes jumped on a lower branch, and both calotes and skink fell to the ground. In a second the skink caught the calotes by the neck, and pulled it under the bush and swallowed the whole calotes in a few minutes.

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24. KILLING OF THE YELLOW MONITOR, *VARANUS FLAVESCENS* (GRAY 1827) (SQUAMATA: SAURIA) IN SOME VILLAGES OF BIRBHUM DISTRICT, WEST BENGAL, INDIA

(*With a photograph*)

The Yellow Monitor or the Yellow-headed Monitor [*Varanus flavescens* (Gray 1827)], though it had quite an extensive former range, is now found only in the Indo-Gangetic plains, south of the Himalayas from Pakistan, east to Brahmaputra river, south to Kutch (Gujarat) in the west and northeastern Orissa in the east (Auffenberg 1986). This species, though apparently common in many places, is but poorly represented in museums (Smith 1935). The Yellow Monitor is generally met with along the marshy borders of small water bodies such as jheels, shallow lakes, etc. Unfortunately, the most favoured habitat of the Yellow Monitor has been drastically modified during the last several decades through agriculture, specially the paddy culture in the southern Gangetic plain. This singular factor appears to be the most important one for causing major depletion in the population of the Yellow Monitor in most pars of its range. Mass killing for hide hunting might also be the other contributing factor towards this (Tikader 1983). For its conservation, this species has been included in Schedule I of the Indian Wild Life (Protection) Act, 1972, as amended up to 1980. Further, it has been included in the Appendix I of CITES. By these, the Yellow Monitor — live or dead or part thereof is totally protected throughout the country and any trade on it is totally banned. The purpose of the present note is to record the mass killing of the Yellow Monitor in spite of legal restrains.

During an excursion on 23rd October, 1986, we were moving through a small patch of grass jungle in Gonpur village, about 20 km. SW of Rampurhat, Birbhum district,

Photo. 1. Showing the dead yellow monitors.

West Bengal. At about 17.00 hours, we met with two tribals who were roasting some rats for their consumption. At the same time we also noticed as many as eleven freshly killed Yellow Monitors with them (Photo 1). On enquiry from them we came to know that they had collected the rats and the Yellow Monitors from burrows and from the crevices of rocks along the canal of Gonput during the day. They had collected the rats for their consumption while the Yellow Monitors would be sold to a 'Hakim' at the rate of Rs. 2/- per animal. They believed that the 'Hakim' would extract oil from the monitors for some medicinal purpose. They could not enlighten us about the fate of the valuable skins. They could not find any eggs of the monitors, which, according to their experience, could be seen only during May-June. On further enquiry, it was revealed that due to lack of jobs in the agricultural fields during the month of October, many people took to collection of the Yellow Monitors as their means of subsistance. They were totally ignorant about the Wild Life Act. They gladly allowed us to take a photograph of the day's 'Shikar', they had made during the day.

The above experience clearly shows that the formulation of acts alone will not be of much help in the conservation of endangered species. Public awareness, socio-economic development together with strict enforcement of the various wildlife protection acts are essential to save the already depleted population of the Yellow Monitor, like any other endangered species.

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25. A NOTE ON PREDATION OF *CATOPSILIA* SP. (LEPIDOPTERA: PIERIDAE) BY BIRDS AND WASP

While recording observations on seasonal abundance of *Catopsilia*, a leaf defoliator of medicinal crop, Senna (*Cassia angustifolia*), it was found that despite high larval count the pupal population was found to be very low to almost zero. This extremely low pupal population of the pest led us to investigate into the causes of larval mortality. Close observation revealed the predation of these larvae by the house sparrows and predatory wasps. To determine the efficiency of the predators, 54 larvae were released initially in an area of 3.5 m × 3.5 m at 0600 hrs on 4.10.1984. The number of larvae was reduced to 3 within 12 hrs (i.e. at 1800 hrs). To get confirmatory results, a regular study was made, where 35 to 50 larvae were released in each of the three plots of 3.5 m × 3.5 m plots selected from ¼th acre senna field and predation by the predators was closely observed with the help of a binocular starting from 0600 to 1800 hrs. The birds were kept out of one of the plots to determine the predation by birds in other two plots. The observations on the larval count were recorded at every three hours. Such a study was made 3 times during October and November 1984 at the Agronomy Farm of the Gujarat Agricultural University, Anand Campus, Anand. The results obtained are presented in Table 1. Data presented in Table 1 show clear cut impact of the predation by birds and predatory wasps. During the early part of observations (10th October), it was the House Sparrow, *Passer domesticus* which was found actively searching for the *Catopsilia* larvae. The sparrows were observed to carry the larvae to the nests made around farm buildings, to feed their nestlings. This high activity of sparrows resulted in considerable reduction in larval count at the end of 1800 hrs observation in the experimental plots. Since, the birds were scared manually in the control plot, it was not possible to have total check on the birds entering from adjoining areas. And since, the sparrows hop considerable distance on ground in search of larvae, their entry in control plot can not always be noticed. This was reflected in our observations in control plot on October 16th, when 20 larvae were seen missing at the end of the day. Very little sparrow activity was however, observed on 10th Nov. This was because of the fact that

TABLE 1

PREDATION OF *Catopsilia* BY BIRDS AND PREDATORY WASP ON SENNA DURING 1984

Dates of observation	Experiment plot Control	No. of *Catopsilia* larvae released	No. of *Catopsilia* larvae recorded after 0900 hrs	1200 hrs	1500 hrs	1800 hrs
16-10-84	Plot — 1	35	30	23	18	3
	Plot — 2	35	26	9	3	2
	Control	35	33	27	17	15
10-11-84	Plot — 1	35	28	26	26	10
	Plot — 2	35	30	28	28	15
	Control	35	35	35	33	29
17-11-84	Plot — 1	50	46	11	3	0
	Plot — 2	50	40	11	4	0
	Control	50	42	38	19	8

their breeding season was almost over. The cessation of breeding of sparrow during October has also been reported from Vadodara by Naik and Mistry (1980). Besides the House Sparrow, another two resident bird species, Common Myna, *Acridotheres tristis* and Redvented Bulbul, *Pycnonotus cafer* were also occasionally found predating on *Catopsilia* larvae. Despite low activity of sparrow and occasional feeding on the *Catopsilia* larvae by Common Myna and Redvented Bulbul, reasonable reduction in the larval count in the experimental plot was recorded in 10th November study. During this period, a few wasps (Vespidae) were also observed carrying away *Catopsilia* larvae to feed their larvae developing in the earthern nests made around the farm buildings. Examination of such earthen nests around the farm revealed the presence of good number of *Catopsilia* larvae. The number of wasp, however, increased on 17th November. As many as 14 larvae were actually seen picked up by the wasps. During the same period three species of migratory birds, Bluethroat, *Erithacus svecicus,* Collared Bush Chat, *Saxicola torquata* and Plain Wren Warbler, *Prinia subflava* were also seen feeding on *Catopsilia* larvae. Their combined predation almost eliminated the larval population from the experimental area. Although the birds were kept out of the control plot, there was considerable reduction in the larval population. This reduction was largely due to the predatory wasps, which were abundant and could not kept out of the control plot.

Thus, from the above observations it is evident that birds such as *Passer domesticus, Erithacus svecicus, Saxicola torquata, Prinia subflava, Acridotheres tristis, Pycnonotus cafer* and the predatory wasp, play very important role in reducing *Catopsilia* larvae in senna. Such natural control agents, as far as possible should be encouraged. Although, it is established fact that sparrows are generally granivorous, during their breeding season they collect a large number of insects to feed their nestlings. In view of this, it would be worthwhile evaluating their beneficial role before calling them as pests in other agricultural crops.

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26. RECORD OF NEW ALTERNATE HOST PLANTS OF SPINY BOLLWORM *EARIAS INSULANA* BOISDUVAL

Spotted bollworms are considered to be the most destructive pests of cotton and okra under Indian conditions. Among them, *Earias vittella* (F.) and *E. insulana* (Boisd.) cause considerable damage to both these crops. Besides cotton and okra, they are known to attack many other malvaceous plants (Khan *et al.* 1946 and Bilapate 1983). Since not much is known as to how these two bollworms survive during the off season in the Northern cotton growing belt of the country, an intensive survey was made during the off season, i.e. from December, 1984 to April, 1985 in various agricultural farms and farmer's fields around Hisar.

Among the various malvaceous plants surveyed, *Abutilon indicum* (L.), *Hibiscus rosa-sinensis* L., *Althaea rosea* L. *Malope trifida* (Cav.), *Dombeya spectabillis* (Bojer) were found to be alternate host plants of the spiny bollworm in this region. Of these, *M. trifida* and *D. spectabillis* were recorded to be the most favoured alternate host plants of *E. insulana.* On an average, 3 eggs and 3 larvae/50 fruits of *M. trifida* were recorded during February-March, 1985 from the field and fruit damage on this host plant was recorded to the extent of 8.0 per cent. Similarly, 8.0 eggs and 2.6 larvae/50 fruits were noticed on *D. spectabillis* and fruit damage on this tree was upto the extent of 11.3 per cent. Eggs and larvae brought to the laboratory from these host plants were successfully reared on them to the adult stage. It is, therefore, concluded that *M. trifida* and *D. spectabillis* are the new alternate host plants of *E. insulana* is this region. Perusal of literature reveal that these plants have been previously reported as the host plants of the spiny bollworm.

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27. FIRST RECORD OF *COCCINELLIMERMIS* RUBTZOV (MERMITHIDAE) FROM INDIA

Though many species of Coccinellids are parasitized by nematodes (Richerson 1970), *Coccinella septempunctata* L., an aphidophagous species, has been found to harbour *Parasitylenchus coccinellae* (Iperti and Van Waerebeke 1968), *Mermis coccinellae* Dies and *M. nigrescens* Duj (Richerson 1970). Information on the parasites of *C. septempunctata* is rather scant in India.

During the course of collection and rearing of *C. septempunctata* in May to August 1981, the lady bird beetles were noticed to be parasitised by nematodes. Nine nematodes emerged from the abdominal region of *C. septempunctata* as has been shown to occur in the case of the larva of *Perilitus coccinellae* Schrank (Hodek 1973). Four of them emerged through the membranes between 2nd and 3rd, three between 5th and 6th and two between 6th and 7th abdominal tergites. The time taken by the worms to come out was between 12 and 29 minutes. The length and breadth of the nematodes ranged from 9.2 to 11.1 cm and 0.62 to 0.92 cm respectively, the average length and breadth being 10.02 ± 0.57 cm and 0.71 ± 0.11 cm respectively. The weight of the worms ranges from 3.8 to 8.6 mg, the average weight being 6.4 ± 1.71 mg.

The nematode worms were identified by Prof. D. J. Hunt of Commonwealth Institute of Parasitology as juveniles of *Coccinellimermis* Rubtzov 1978. In a personal communication dated March 31, 1982, he wrote as follows: "The nematodes are juvenile mermithids of the genus *Coccinellimermis* Rubtzov. Adult stages are unknown. However, if you find further specimens emerging from Coccinellids, they can be placed in a tube containing damp sand and left for several weeks to enable the nematodes to moult to the adult stage before preservation. *Coccinellimermis* belongs to the Mermithidae."

Out of 634 beetles collected during the months of May to August, 1981 only 10 showed nematode infection, i.e., 1.57%. Prior to the escape of the worms the lady bird beetles show hyperactivity for about 30 to 50 minutes.

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DEPARTMENT OF ZOOLOGY,
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UDHAGAMANDALAM - 643 002,
February 11, 1986.

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28. FIRST RECORDS OF PREDATORS OF COTTON PESTS IN THE PUNJAB

During surveys of the cotton crop from 1980-82 in the main cotton belt of the state (Ferozepur, Faridkot and Bhatinda districts) and in Ludhiana, adults of a number of predators were observed feeding on the insect pests of cotton for the first time. *Paedrus fuscipes* Curtis (Staphylinidae; Coleoptera), *Geocoris ochropterus* Slater (Lygaeidae; Hemiptera), *Coranus aegypticus* Fabricius (Reduviidae; Hemiptera), *Coranus* sp., *Zelus* sp. (Reduviidae; Hemiptera) and *Cerceris* sp. (Sphecidae: Hymenoptera) were feeding on the nymphs of cotton jassid, *Amrasca biguttula biguttula* (Ishida). All of these except *P. fuscipes* sucked the body fluid of the pest. Out of these *G. ochropterus, Coranus* spp. and *Zelus* sp. predated upon the young larvae of pink bollworm, *Pectinophora gossypiella* (Saunders), *Earias insulana* Boisduval and *E. vittella* Fabricius larvae. *Micraspis cardoni* (Weise) mainly predated upon the *Aphis gossypii* Glover. High population of *P. fuscipes* is usually found in Egyptian clover, winter and fodder maize crops from where it migrates to cotton during June. Population of the remaining predators appear on the crop mainly during August and September which is the peak period of boll formation and bollworm attack. However, their population at farmer's fields remained quite low perhaps because of insecticidal applications which needs further investigations. *P. fuscipes* was earlier reported from India attacking rice leaf hoppers in Madhya Pradesh (Upadhyay and Diwaker 1983, Shukla *et al.* 1983).

ACKNOWLEDGEMENTS

We are grateful to Drs R. Madge, H. R. Wilson, M. S. K. Ghauri, B. R. Subba Rao and T. G. Vazirani of the Commonwealth Institute of Entomology, London for identification of the various insects reported in this article.

DEPT. OF ENTOMOLOGY,
PUNJAB AGRIL. UNIVERSITY,
LUDHIANA - 141 004,
June 7, 1986.

JOGINDER SINGH
RAMESH ARORA
A. S. SIDHU

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29. THE HOUSE SPARROW *PASSER DOMESTICUS* (LINN.) AS A PREDATOR OF THE PEACH LEAF CURL APHID *BRACHYCAUDUS HELICHRYSI* (KALTENBACH)

Four peach (*Prunus persica* Batch cv. *Flordasun*) trees planted during January 1978 were present in the compound of one of the houses of the Aggar Nagar residential locality of Ludhiana and were severely infested by peach leaf curl aphid *Brachycaudus helichrysi* (Kaltenbach) and peach mealy aphid, *Hyalopterus pruni* (Geoffrey) every year. In March 1984, house sparrows *Passer domesticus* (Linn.) were seen pecking at the curled leaves of peaches and it was seen that they were feeding on the peach leaf curl aphid. On March 12, 1984, 2, 3 and 3 sparrows were found feeding on these aphids, when the trees were observed at 10.00, 11.00 and 14.30 hrs respectively and again on March 20, 8-10 sparrows were seen feeding on the aphids at 10.20 hr. On April 3, sparrows were again observed to be feeding on the aphid.

In 1985, the curled leaves were observed on February 13 and 2-3 house sparrows per tree were observed on February 16, 1985, feeding on the aphids from the curled leaves. The number of sparrows feeding on this aphid increased as the number of aphid infested shoots increased. On February 28, 1985, minimum 2-3 sparrows were seen feeding on the aphids during the day, whenever the trees were observed.

Feeding behaviour of the sparrows:

The sparrows feed on the aphid colonies sitting on the shoots and eating the aphid by pecking them from the lower side of the leaf about a $\frac{3}{4}$ from top of the shoot or from the curled parts. The sparrows also sit on the adjoining branches and ate the leaf curl aphid from the infested shoots near the branches on which, they sit. In some cases, they caught the growing shoots with their claws and ate the aphid present on the growing shoot.

In all these observations, house sparrows had concentrated their activity in predating the leaf curl aphid and the mealy aphid was spared, this may be due to the more handy location of the leaf-curl aphid (only shoots) as compared to mealy aphid which preferred the leaves of all ages.

In conclusion, house sparrows had a definite liking for peach leaf curl aphid atleast in residential localities and its role in leaf curl aphid regulation may be further investigated.

ACKNOWLEDGEMENT

I thank Dr. Harcharan Singh, Professor-cum-Head, Department of Entomology, Punjab Agricultural University, Ludhiana for providing the facilities.

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LUDHIANA,
May 27, 1985.

30. NEW TAXA OF THE GENUS *LASIANTHUS* (RUBIACEAE)

(*With three text-figures*)

In course of taxonomic study of the genus *Lasianthus* (Rubiaceae) in Indian subcontinent the authors came across some specimens which are distinct from the known taxa. Three of these are described below with illustrations as new varieties.

Lasianthus andamanicus Hook f.
var. **ciliatus** var. nov. (Fig. 1)

differt a varietate typica foliorum nervulis tertiariis glabratis vel glabriusculis; stipulis calycum dentibusque longe ciliatis.

Differing from the typical variety in glabrous or glabrescent tertiary nerves; stipules and calyx teeth long ciliate.

Type: South Andaman, Beadnobad, ± 50 m, 30.11.1973, *N. P. Balakrishnan* 654 *holo.* CAL, *iso.* E, PBL; Dhanikhari, ± 50 m, 31.1.1974, *N. G. Nair* 840 *para.* L, PBL; Herbertabad, sea level, 29.11.1975, *N. G. Nair* 3184 *para.* PBL; Dhanikhari, 16.1.1978, *P. Basu* 6641 *para.* PBL; Little Andaman, Hut Bay, sea level, 1.9.1976, *N. Bhargava* 4339 *para.* CAL; North Nicobar, Mildera, ± 30 m, 4.5.1977, *P. Chakraborty* 5600 *para.* CAL.

Shrubs small, 1-3 m high; branchlets horizontally spreading, glabrous or pubescent, chocolate coloured when dry. *Leaves* petiolate, 5.5-15 × 2.5-5 cm, elliptic, elliptic-oblong or elliptic-lanceolate, acuminate at apex, acute at base, slightly coriaceous, glabrous, glossy, chocolate above when dry, pale beneath, hirsute or pubescent on midrib, secondary and tertiary nerves; midrib shallow channelled above; lateral nerves 6-10 on either side, opposite or subopposite, subparallel, arched, slightly raised above; nervules parallel, forked, faint; petioles 5-12 mm long, pubescent or hirsute; stipules 3-6 × 1-2 mm, lanceolate, long ciliate above; colleters at base beneath. *Inflorescence* axillary sessile cymes, 2-4 flowered, ebracteate; bracteoles absent or very minute, ± 1 mm long, triangular, pubescent. *Flowers* sessile or subsessile, 4-10 mm long, tubular, white; pedicels 0-0.5 mm long, pubescent. *Hypanthium* ± 0.5 mm long, oblong, pubescent. *Calyx* ± 1.5 × 2.5 mm, cupular; teeth 4, triangular acute, ciliate above. *Corolla* tube 8-9 mm long, narrow, pubescent at upper part on both surfaces; lobes 4, ± 3 mm long, oblong, inflexed at apex, pubescent above. *Stamens* 4, included; filaments minute, adnate below the throat; anthers ± 2 mm long, linear-oblong. *Ovary* ± 0.5 mm long, obovoid, 4 celled; ovules solitary per locule, basal, erect; style 8-9 mm long, slender, glabrous; stigma ± 0.5 mm long; 4 lobed, ovate, obtuse; disk 1-1.5 mm across, annulur, smooth. *Fruits* sessile, 5-6 × 3-4 mm, globose or ellipsoid, crowned with persistent calyx teeth, 4 furrowed, purple, blue or black; pericarp thin, pubescent; pyrenes 4, dorsally convex, with irregularly shallow grooves ventrally angled, thick walled, with few raphides. *Seeds* ± 3 mm long, oblong, short stalked; embryo ± 2.5 mm long; radicle inferior, broader at base, cotyledons thin, ovate, acute.

Distribution: Andaman and Nicobar islands, up to 50 m in altitude.

Lasianthus lucidus Bl.
var. **caudisepalus** var. nov. (Fig. 2)

differt a varietate typica bracteolis triangularibus, calycum dentibus brevissimis, triangularibus.

This differs from the typical variety in having triangular bracteoles and calyx teeth very short, triangular.

Type: Arunachal Pradesh, Subansiri dist., Apa Tani valley, Hapoli, 1590 m, 26.4.1965, *Cox & Hutchinson* 499 *holo.* K, *iso.* E; Apa

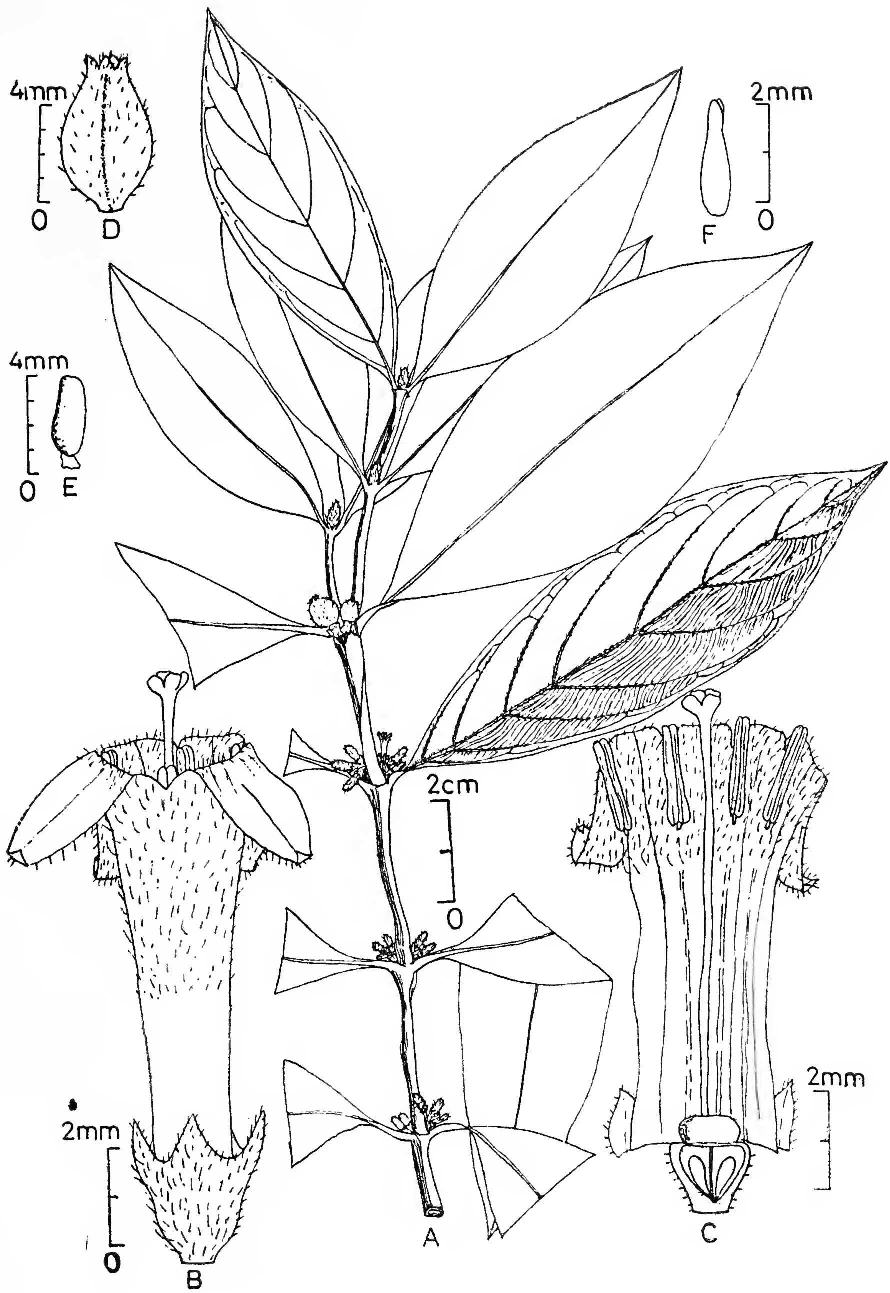

Fig. 1. *Lasianthus andamanicus* Hook. f. var. *ciliatus* var. nov.
A. Habit; B. Flower; C. Opened flower; D. Fruit; E. Seed; F. Embryo.

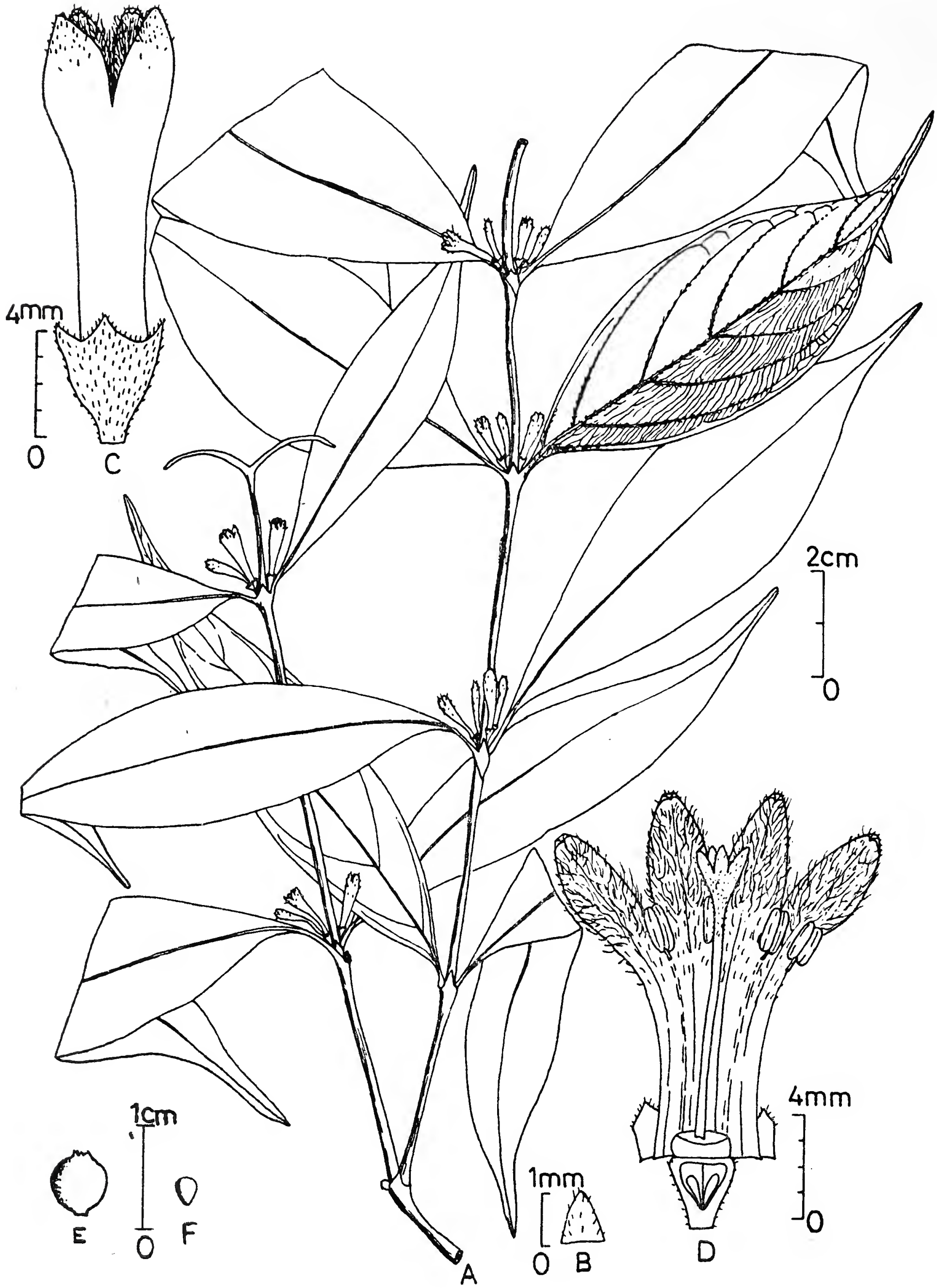

Fig. 2. *L. lucidus* Bl. var. *caudisepalus* var. nov.
A. Habit; B. Bracteole; C. Flower; D. Opened flower; E. Fruit; F. Seed.

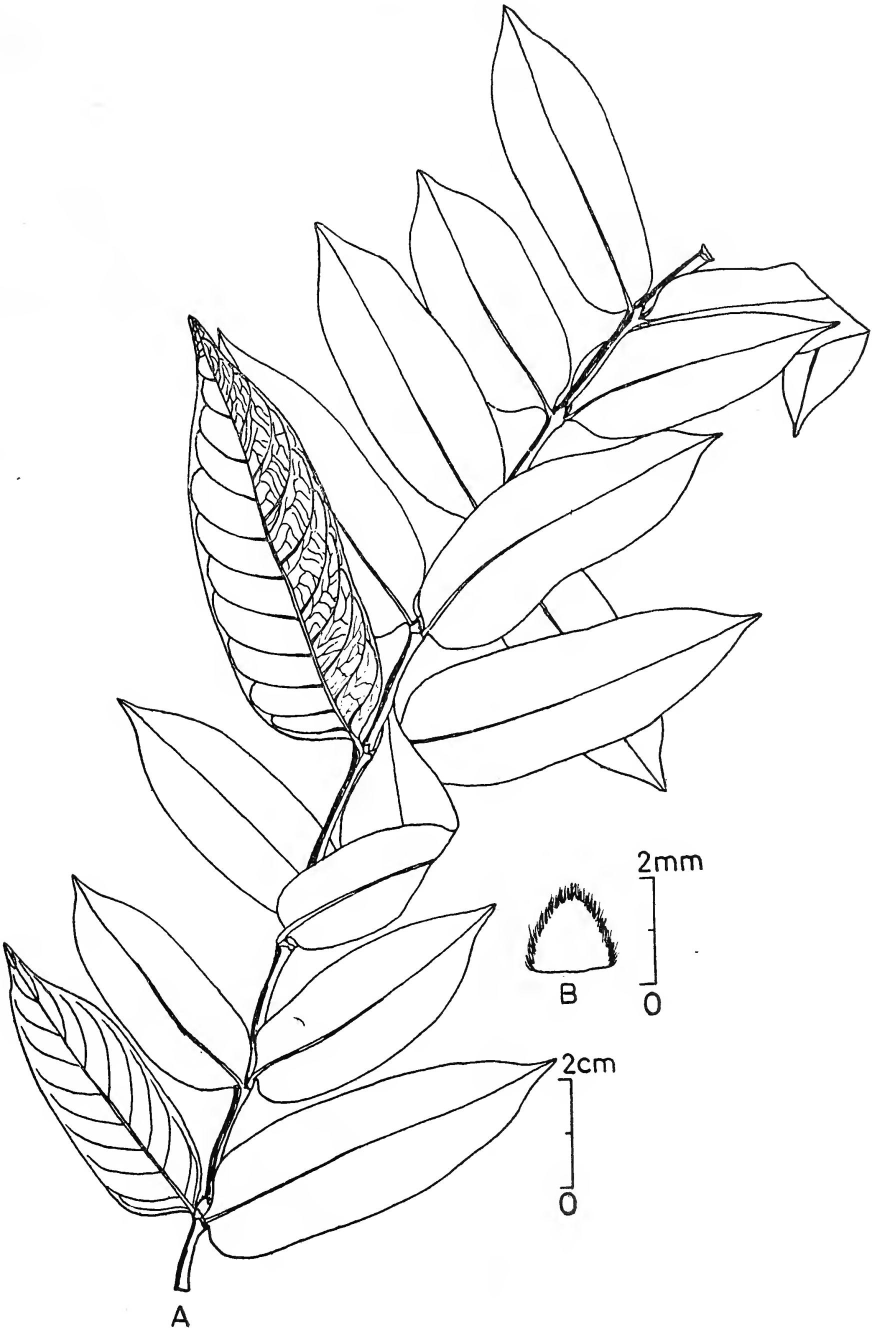

Fig. 3. *L. wallichii* Wt. var. *glabriusculus* var. nov.
A. Habit; B. Stipule.

Tani valley, 1620 m, 22.4.1965, *Cox & Hutchinson* 476 *para* E; Hapoli, 30.9.1959, *G. Panigrahi* 19813 *para.* ASSAM; Meghalaya, Nonglan, 1350 m, 3.11.1873, *C. B. Clarke* 20049 *para* K.

Shrubs 1.8-3 m high; branchlets slender, glabrescent or strigose. *Leaves* petiolate, 7.5-13 × 2-4 cm, elliptic-oblong or oblanceolate, caudate-acuminate at apex, acute at base, thin, membranous, glossy; midrib flattened; sparsely strigose; lateral nerves 5-6 on either side, opposite or subopposite, slender, arched; nervules subparallel, forked, inconspicuous above; petioles 4-10 mm long, slender, strigose; stipules 2-3 × 1.5-2 mm, ovate or triangular, acuminate, strigose, few colleters at base beneath. *Inflorescence* axillary subsessile cymes, 2-5 flowered; peduncle ± 1 mm long, strigose; bracteoles ± 1 mm long, triangular, acute, sparsely strigose. *Flowers* subsessile, short pedicelled, 14-16 mm long, tubular, white or light lilac, deeper outside; pedicels up to 0.5 mm long, strigose. *Hypanthium* ± 1 mm long, obovoid, strigose. *Calyx* ± 1 × 2.5 mm, cupular, strigose above; teeth 4 or 5, triangular, acute. *Corolla* tube 8-9 mm long, glabrous above, villous beneath at throat; lobes 4, ± 4 mm long, ovate, sparsely puberulous above, villous beneath. *Stamens* 4, included; filaments minute, adnate below throat; anthers ± 1 mm long, oblong. *Ovary* ± 0.5 mm long, obovoid, 4 celled; ovules one per locule, basal, erect; style ± 10 mm long, puberulous above; stigma ± 1 mm long, 3 lobed, ovate, obtuse, papillose; disk 1-1.5 mm across, flattened, smooth. *Fruit* sessile, 4-5 × 4-5 mm, globose, crowned by calyx lobes, 5 angled, grooved; pericarp thin, glabrous; pyrenes 5, obovoid. *Seeds* ± 2 mm long, obovoid, smooth.

Flowering: April-August; *fruiting*: September-November.

Ecology: Grows in subtropical forest at 1590-1620 m in altitude.

Distribution: Arunachal and Meghalaya.

L. wallichii Wt.

var. **glabriusculus** var. nov. (Fig. 3)

differt a varietate typica foliis glabriusculis, stipulisque latissimis ovatis.

Differs from the typical variety in having almost glabrous leaves and broadly ovate stipules.

Type: Burma, 1.3.1849, *Falconer* 885 *holo.* & *iso.* CAL.

Shrubs; branchlets compressed, glabrescent, pubescent when young, warty in age. *Leaves* petiolate, 5-9 × 2-3 cm, oblong, acuminate at apex, slightly unequally obtuse at base, coriaceous, glabrous; pale green when dry; midrib slender, slightly raised, channelled above, hirsute beneath; lateral nerves 10-12 on either side, subopposite, subparallel, arched at margin, conspicuous beneath; nervules irregularly forked, inconspicuous; petioles 2-4 mm long; stipules ± 2 ×3 mm broad, ovate, acute at apex, pubescent beneath. *Flowers* and *fruits* not seen.

Distribution: Burma.

ACKNOWLEDGEMENTS

We are grateful to the Directors and Keepers of the Royal Botanic Gardens, Kew, Royal Botanic Garden, Edinburgh, Rijksherbarium, Leiden, Deputy Director, Eastern circle, BSI Shillong and Regional Botanist, Andaman and Nicobar circle, Port Blair for loan of specimens. Thanks are also due to Director, Botanical Survey of India and Deputy Director, Central National Herbarium, Howrah for necessary facilities.

BOTANICAL SURVEY OF INDIA,
HOWRAH,
April 25, 1986.

D. B. DEB
MOHAN GANGOPADHYAY

31. MASSIVE OCCURRENCE OF *ENHYDRA FLUCTUANS* LOUR. (ENYDRA) IN CITY POND

(*With a text-figure*)

The Bandra pond and its vegetation attracted our attention about 10 months ago when a curious citizen brought a strange plant for identification. Unfortunately, the plant was in sterile condition at that time, and as it was novel to Bombay and Maharashtra, it kept us guessing about its identity, till very recently when we were able to collect it in bloom and ascertain its identity after critical study.

Bandra pond, which was famous for the eye-catching *Lotus* flowers till few years ago, now nourishes the growth of unwanted weeds which has been a cause of concern to local inhabitants and naturalists. With this point in mind a study of vegetation of this pond was undertaken as a project work for the undergraduate students.

The critical study on the plant revealed that it is a member of Compositae, *Enhydra fluctuans* Lour. This species has been earlier reported from West Bengal, Bihar and Orissa from Northern India. It is not included either in Cooke's Flora of Bombay Presidency or in Flora of Madras Presidency by Gamble. However, it has been reported from present Maharashtra state by Karthikeyan *et al.* in Records Bot. Surv. India 21(2): 169. 1981, without mentioning any precise locality. After enquiring with Mr. Karthikeyan about the occurrence of this species in Maharashtra, it is revealed that he has reported this species based on Paradkar-43, collected on 15-3-1963 from Nagpur College premises. Mr. Karthikeyan further states in his letter that before publication of his paper, he saw the specimen in the Herbarium of Botanical Survey of India, Western Circle, Poona (BSI), but subsequently the specimen has been misplaced by somebody, and he could get only the reference card. From this information it appears that this is a new report of this species from Maharashtra. Since it is an addition to Cooke's Flora and Madras Flora and since there is no figure available for this species, we give below the full details of the plant with line drawings.

A decumbent, branched, fleshy, submerged aquatic herb rooting at nodes. Roots long, unbranched, stout and cylindric. Stem rounded, cylindric with long internodes, fleshy, hollow in the centre, purple at the nodes, with scattered white hairs when young. Leaves simple, opposite, linear-oblong, fleshy, gland-dotted, distantly short-toothed, acute at the apex, sessile, with a prominent midrib, glabrous. Inflorescence terminal and axillary, sessile, rounded head surrounded by leafy, involucral bracts. Bracts in 2 whorls, persistent; outer 2 bracts ovate-oblong, 1-1.5 cm long, 0.6-0.8 cm broad, rounded at base, slightly narrowing and acute at the apex, 4-6 veined, gland-dotted in the upper half, glabrous. Inner bracts 2, broadly ovate, 0.5 cm broad, green, 4-6 veined, rounded at base and apex, fleshy, glabrous. Head heterogamous-rayed Florets arranged centripetally on a fleshy, rounded to concave receptacle. Ray florets (pistillate florets) at the periphery, arranged in many series. Ovary oblong, white, 0.4-0.45 cm long, 0.1-0.2 cm broad, white flat on upper surface, compressed and 2 sided on the lower surface; ovule 0.1 cm long, erect, shining. Style slender, 0.2-0.3 cm long, linear; stigma deeply 2 fid, exserted, curved inwards, slightly coloured. Palea long, covering the ovary, hairy at the apex; hairs

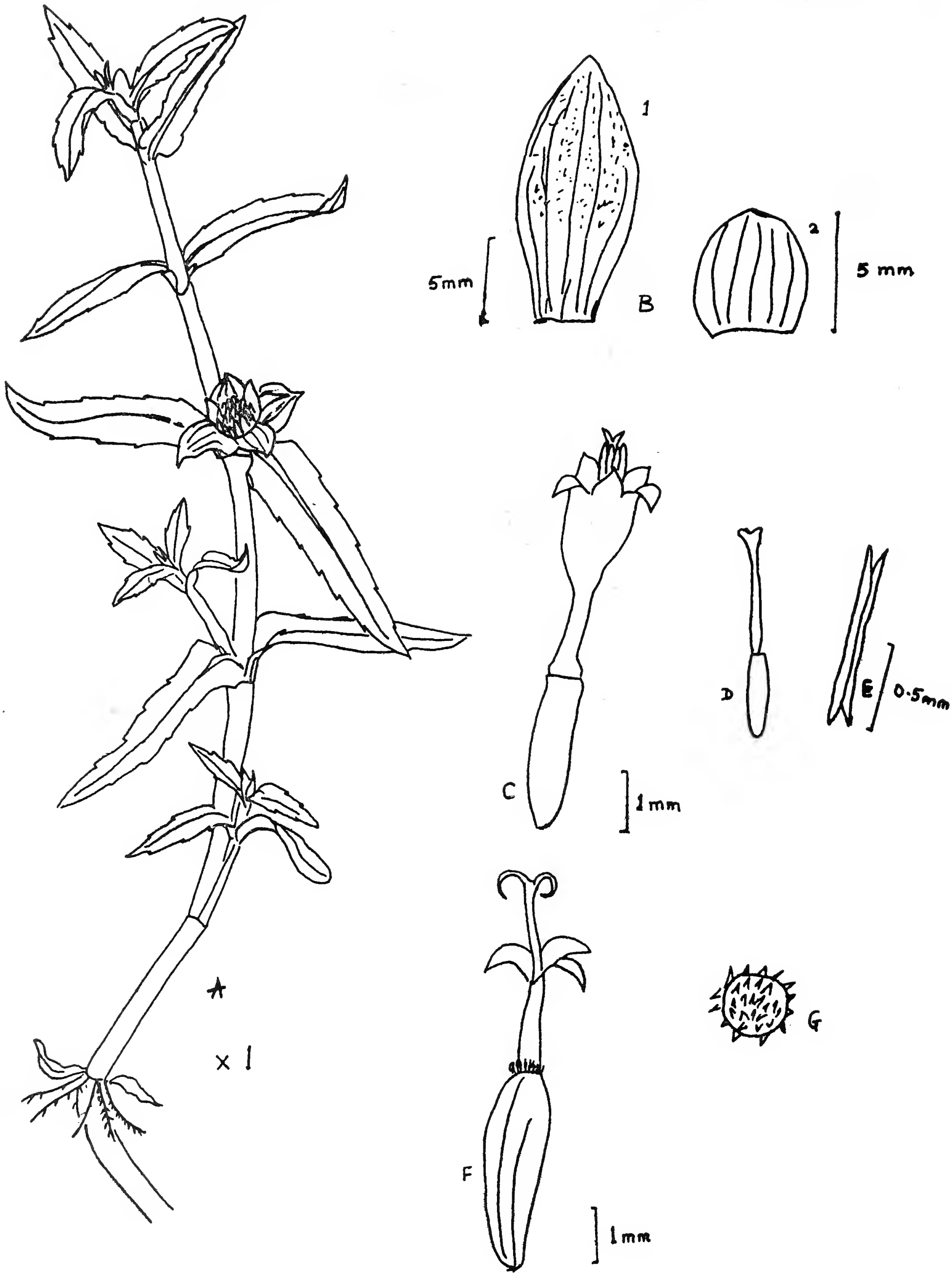

Fig. 1. *Enhydra fluctuans* Lour.
A. Habit; B. 1. Outer bract, 2. Inner bract; C. Disc floret; D. Pistil; E. Anther; F. Ray floret; G. Pollen.

few. Corolla ligulate, tube very short, green, swollen and rounded at base, divided halfway above into 3-4 lobes; lobes white with purple tinge, 0.05-0.1 cm long. Disc florets (bisexual floret) few in the centre of the receptable, 0.8-1 cm long; palea sheathing, 0.4-0.5 cm long, toothed at the apex. Corolla tube swollen and rounded at base, linear in the middle, broad at apex, divided into 5 ovate, acute lobes. Stamens 5, epipetalous, syngenecious; anthers linear obtuse at base and apex, pollen grains rounded and spiny; ovary oblong, white, with one erect ovule, style stout, cylindric, 0.5 cm long, shortly divided into 2 stout, fleshy, stigma lobes; cypsela oblong, laterally compressed.

An abundant aquatic weed, recently introduced in the pond. For the last 10 months, we have watched the plant and its growth. It occupies almost half of the lake in pure formations, partially submerged under water with only the upper half remaining erect above the water level. Birds of various types visit the pond in different seasons from different parts of the country, and feed upon the plants of the pond.

This species is an aromatic or essential oil yielding plant. Internal structure of the plant is typical of a dicot plant having normal secondary growth, adapted for aquatic life.

Flowering & Fruiting: January-March. *Locality*: Bandra Pond. *Exsiccata*: SMA — 6001, 6010.

We are grateful to Mr. M. R. Almeida and Mr. G. G. V. B. Rao for the help rendered in preparing this article.

BLATTER HERBARIUM,
ST. XAVIER'S COLLEGE,
BOMBAY - 400 001,
April 25, 1986.

S. M. ALMEIDA
A. R. DARUWALLA

32. OCCURRENCE OF THREE INTERESTING PLANTS AT NANDUR MADHMESHWAR, NASIK DISTRICT, MAHARASHTRA

(*With three text-figures*)

Nandur Madhmeshwar reservoir, also known as 'Khandgaon Thadi' is situated about 55 km away from Nasik in Nasik District has three large islands in the middle and an abundance of aquatic vegetation. It has become a excellent birdwatching area for waterfowl both resident and migratory. There is a proposal to declare the area as a 'Bird-Sanctuary' by the Government of Maharashtra.

It was decided to work on the flora of this interesting area as there is no data on its plant life. A number of field trips were made in different seasons and some interesting features of the flora were noted.

This paper describes the occurrence of a new plant for Maharashtra and two common but less known species.

1. **Cocculus pendulus** (J. R. & G. Forst.) Diels in Engl. & Prantl. 4. 94:237, fig. 78, 1910; Gamble, Fl. Pres. Madras 1: 29,

1915; Hutchinson & Dalziel, Fl. W. Tr. Afr. 1: 79, 1927 (ed. 1) & 1: 76, 1954 (ed. 2); G. Troupin, Fl. E. Tr. Afr. Menisp. 10. 1956. (Fig. 1).

Epibaterium pendulum J. R. & G. Forst. Ghae. Gen. 108, t. 54, 1776.

Menispermum leaba Del., Fl. Egypt, 140, t. 51, fig. 2-3, 1813.

Cocculus leaeba (Del.) DC. Syst. 1: 529, 1818 and Prodr. 1: 99, 1824; Hook. f., Fl. Brit. Ind. 1: 102, 1872; T. Cooke, Fl. Pres. Bombay 1: 21 (23), 1901; Talbot. For. Fl. 1: 42-43, 1909; Bamber, Pl. of Punjab, 605, 1916.

A scandent climbing shrub.

The species has been reported from Karachi-Sindh by T. Cooke; Valleys below Simla, and Rawalpindi by Bamber; from Carnatic by Hooker; from Madurai, Madras by Gamble; from Porbunder by Woodrow; and from Kutch and Saurashtra by Shah; Talbot has reported it earlier from Nasik, Nagar & Pune but subsequently there is no report of the species from Maharashtra.

The species is very poorly represented in various herbaria in Maharashtra. There are only 4 specimens in Blatter Herbarium; of which 3 are from Gujarat (H. Santapau: Jamnagar — 7692, 7706; Irani: Julunder Bet, Kutch — 5312 and the other from Karachi (s.n., s.l., 1892).

Rare in the locality, a male plant growing on *Azadirachta indica* west of Khandgaon riverbed was collected on a *Euphorbia* hedge.

Our identification is based on the description given by Cooke and was confirmed by matching the specimen with Blatter Herbarium specimens, which have been identified at Kew.

Flowering: October-January.

Exsiccata: RDS — 500, 669, 885; MRA — s.n.

2. **Vicia sativa** Linn. Sp. Pl. 736, 1753; Baker in Hook. f. FBI 2: 178, 1876; Fyson Fl. of Nil. & Pul. Hills-tops, 1:117, 1915 & 2: t. 88, 1915; Gamble, Fl. Pres. Madras 1: 246, 1957; Ali in Bot. Notiser 120: 48, 1967 & Fl. Pak. 100 (Pap): 269, fig. C, 1977 (only habit). (Fig. 2).

Annual herb, erect or climbing. Leaves paripinnate. Rachis ending in twisted tendrils.

The species has been reported from South Nilgiri hills by Fyson & Gamble; from Dehra Dun by D. R. Babu and from Gujarat by G. L. Shah. At BLAT there is only one specimen collected from Nilgiris by L. J. Sedgwick 1626, July 1916. There is no earlier record of the species from any part of Maharashtra.

A rare species in this locality growing east of the reservoir towards the Manjargaon in the waste-lands and on the dry riverbed. Our identification is based on the description given in Fl. Pak. by Ali and was confirmed by comparing with the herbarium specimen of Sedgwick — 1626; deposited at BLAT.

Flowering: December-January.

Exsiccata: RDS — 363, 934.

3. **Pluchea tomentosa** DC. in Wt. Contr. 16, 1834; DC. Prodr. 5: 450, 1836; C. B. Clarke, in Comp. of Ind. 94, 1876; Hooker f., FBI 3: 272, 1882; Woodrow in Journ. BNHS, 11: 648, 1898; T. Cooke, Fl. Pres. of Bombay 1: 25 (2: 81), 1904; Gamble, Fl. Pres. Madras, 1: 690 (2: 485), 1915; Duthie, Fl. Upp. Gang. Pl. 1: 418, 1960. (Fig. 3).

A shrub generally, 1-2.5 m tall, sometimes growing up to 3 to 4 m in height with support of other plants.

The species is poorly represented in Indian herbaria. After referring to different herbaria, we found that there are 9 specimens at Bota-

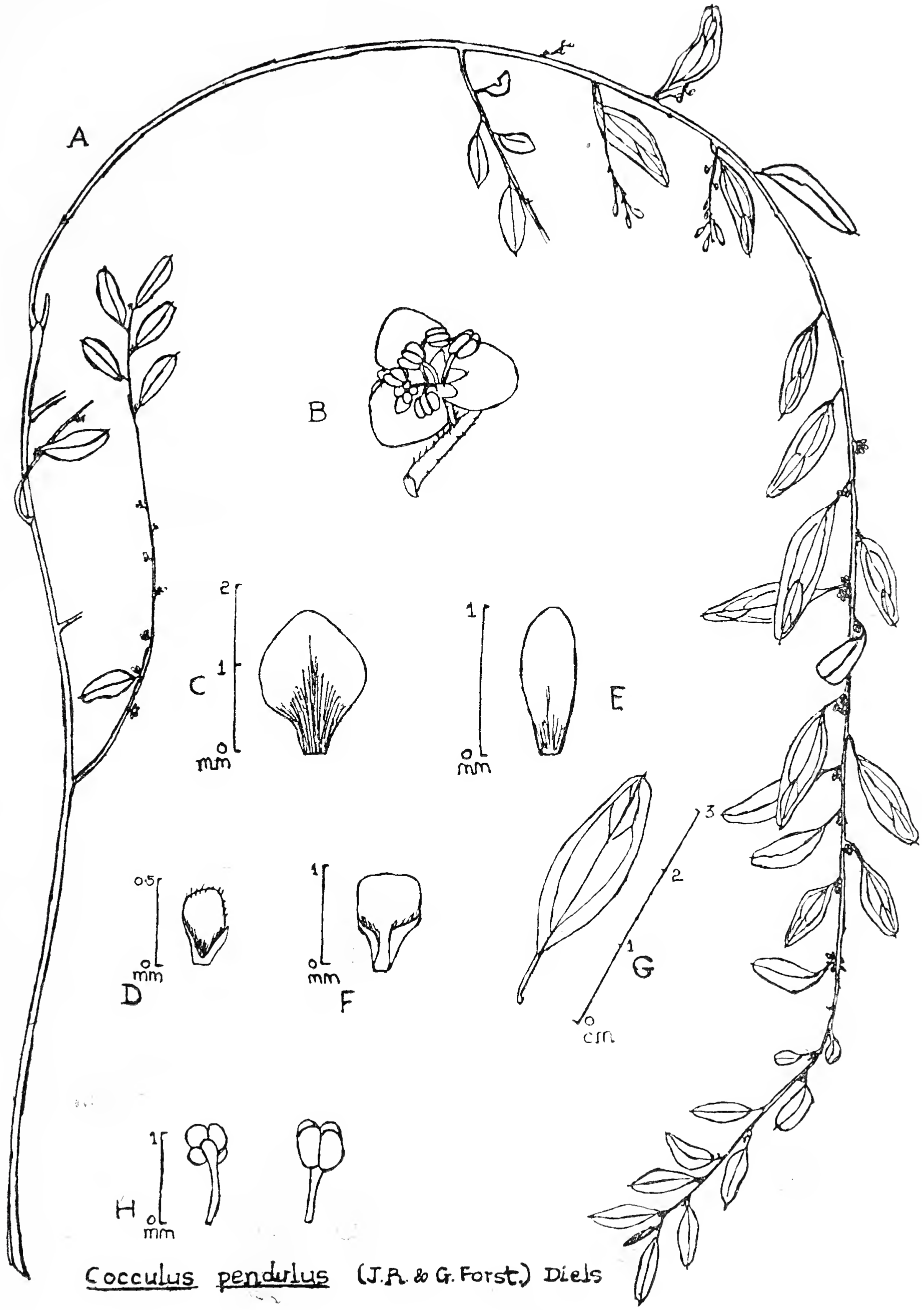

Fig. 1. *Cocculus pendulus* (J.R.&G. Forst.) Diels
A. Habit; B. Open flower; C. Inner sepal; D. Outer sepal; E. Inner petal; F. Outer petal; G. Leaf; H. Stamens.

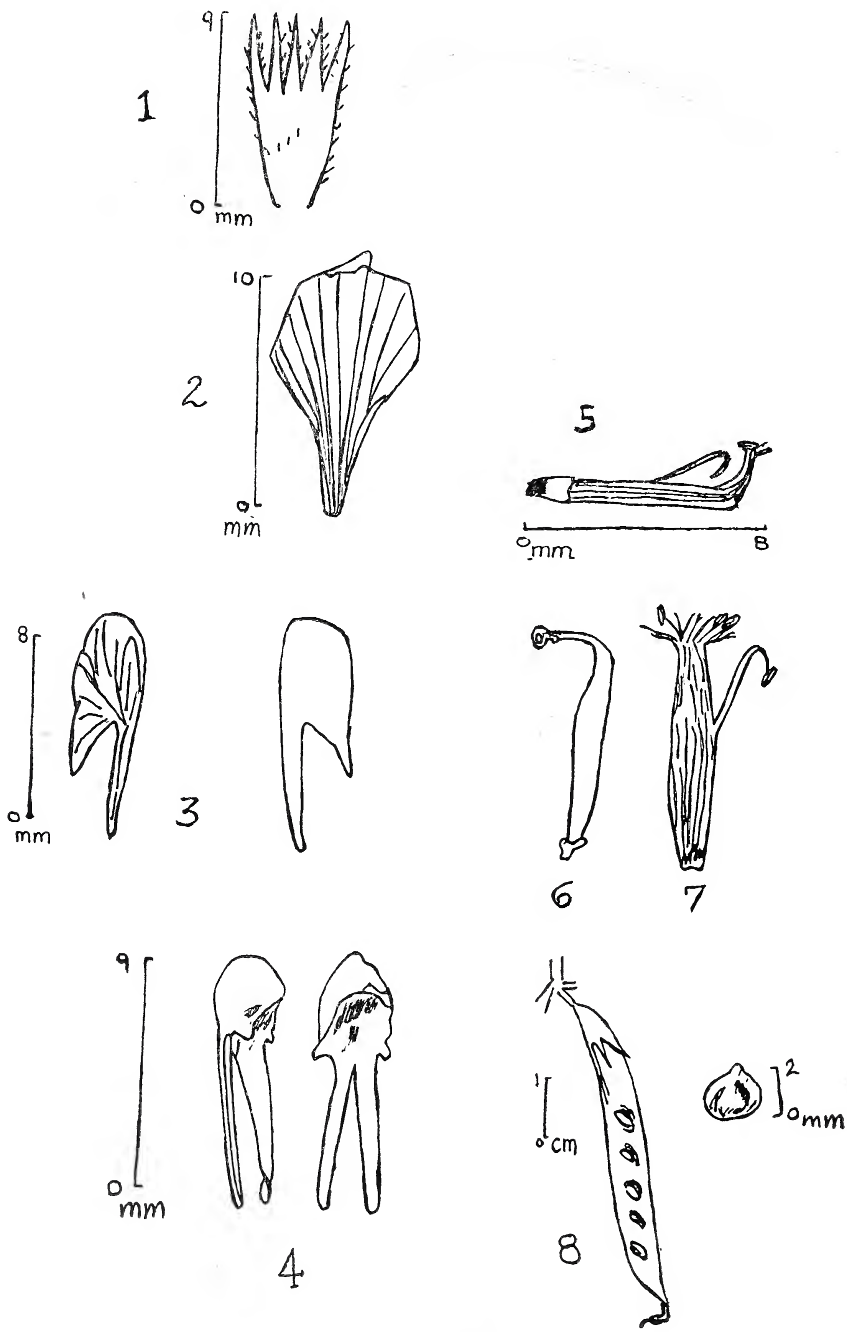

Fig. 2. *Vicia sativa* L.
1. Calyx; 2, 3 & 4. Corolla (standard, Wing & Keel); 5. Staminal tube; 6. Gynoecium; 7. Stamens; 8. Pod and seed.

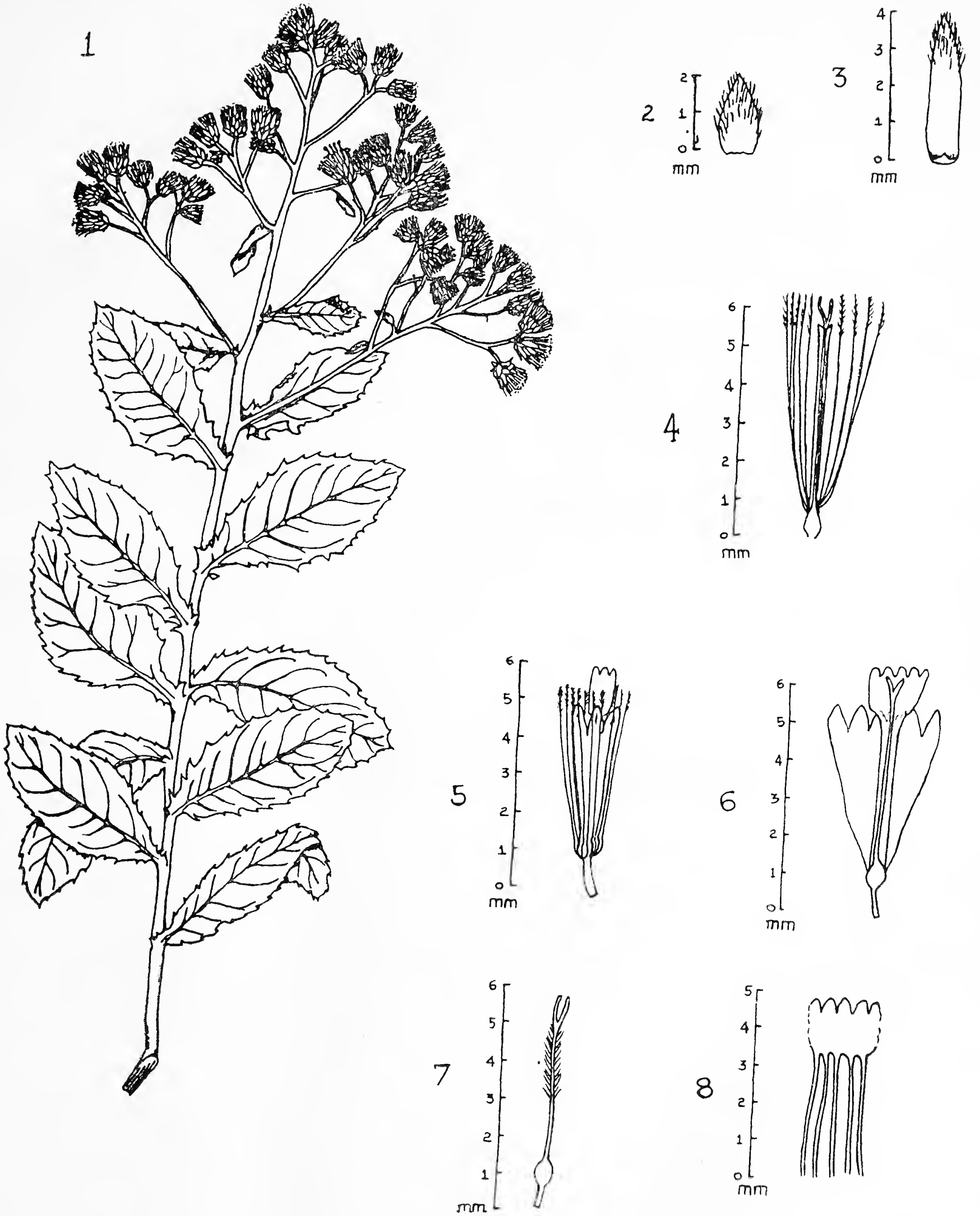

Fig. 3. *Pluchea tomentosa* DC.
1. Habit; 2. Outer involucral bract; 3. Inner involucral bract; 4. Outer ♀ flower; 5. Disc flower; 6. Open disc flower; 7. Pistil; 8. Stamens.

nical Survey of India, Western Circle, Pune (BSI) herbarium, of which six were collected by T. Cooke (no locality and field data is mentioned); and one by D. Prain in 1902 (without any locality). There are six specimens in Dehradun herbarium and three sheets in the National herbarium, Calcutta, of which one is from Sinhgad, Pune (1957). In Blatter herbarium, there are only two specimens from Dharwad, collected by L. J. Sedgwick (2382 & 3454 in 1917).

T. Cooke in Fl. Bombay Pres. has mentioned Konkan and Thalghat, as localities for this species, but there is no representative specimens from these localities in any of the herbaria.

The plant is very common in Nandur Madhmeshwar area. It grows well up to 4 m tall with the support of other trees, and occupies large area of water-logged marshy land.

Our identification is based on description given by T. Cooke and was confirmed by matching the specimens collected by Sedgwick, deposited at BLAT.

Flowering: December-February.

Exsiccata: RDS — 2, 85, 691; MRA — 20.

We are grateful to Rev. Fr. John Misquitta, S. J., Principal, St. Xavier's College, Bombay to Mr. M. B. Almeida for guidance; to Mr. V. K. Mohan, Forest Officer, for providing facilities for staying at Khandgaon-irrigation bungalow during field trips; to Mr. Debi Goenka and Ms. Heta Pandit for the assistance and help during the field trips and to Mr. Kevin D'Cruz for drawings.

BLATTER HERBARIUM,
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May 24, 1986.

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33. NOMENCLATURAL NOTES ON *EMBELIA ROBUSTA* AUCT. MULT., NON ROXB. (MYRSINACEAE)

Almeida and Almeida (1984) proposed the combination, *Embelia acutipetalum* (Lam. ex Hassk.) Almeida and Almeida based on *Basal acutipetalum* Lam. ex Hasskarl, Hort. Malab. *Rheed.* Clavis: 40. 1867 for the species known as "*Vidingi*" in Maharashtra, a species of great medicinal value and for which Cooke (1904) used the name, *Embelia robusta* Roxb., citing both *Embelia tsjeriam-cottam* (Roem. et Schult.) A. DC. and *E. Basaal* (Roem. et Schult.) A. DC. in synonymy. But the former is based on *Ardisia*? *tsjeriam-cottam* Roem. et Schult. (1819) and the latter on *A. Basaal* Roem. et Schult. (1819). Both these basionyms have not only priority over *E. robusta* Roxb. (1820), but also both these names are now accepted (cf. Gamble, 1921) as taxonomically distinct from *E. robusta* Roxb.

Hasskarl (1867), in proposing the name *Basal acutipetalum* Lam. ex Hassk., cited *Dauceria acuta* Dennst.,; Steudel, Nom. 1: 485 (1840), '*Ardisia*? *Basaal* R. S. S. V. IV. 517 . . . *E. Basaal* A. DC.', as direct synonyms. Therefore, *Basal acutipetalum* Lam. ex Hassk. must be treated as a superfluous illegitimate name for *E. basaal* (Roem. et Schult.) A. DC. (Art. 7. 11; Art. 63. 1). Further, in as much as *Dauceria acuta* Dennst. ex Steudel (1840) published without a description, is validated by reference to '(Hort. mal. V. 12)', albeit a

Pre-Linnaean publication, (Art. 32.2, Ex. 3; Art. 7. 13), its citation as a direct synonym of *Basal acutipetalum* Lam. ex Hassk. (1867), renders the latter doubly superfluous (Art. 7. 11; Art. 63. 1).

In this connection, we must emphasise that Lamarck in 'Enc. 1: 381. 1' did not establish *Basal acutipetalum,* as attributed to Lamarck by Hasskarl (1867); Lamarck in 'Dict. Encycl. de Bot. 1: 381. 1789' referred to: 1. *Basaal or Basal,* Rheed. Hort. Malab. 5: 23, t. 12: 2. *Basal, Tsjeriam-cottam* Rheed. l.c.: 22, t. 11 and without suggesting any specific epithet for either of them, gave detailed comments in French.

Although *Dauceria* Dennst. (1818), an invalid name (Manitz, Taxon 17: 500. 1968), was validated by Steudel (1840) by referring to it 'Pattara Adans.' (1763), *Dauceria* Dennst. ex Steudel (1840) must be rejected as a superfluous illegitimate name for *Pattara* Adans. (Art. 7. 11; Art. 63. 1), despite the fact that *Pattara* Adans. is *nom. rej* for *Embelia* N. L. Burman (1768). All the same, *Dauceria acuta* Dennst. ex Hassk. and *D. obtusa* Dennst. ex Hassk., are not illegitimate (Art. 68. 1) merely because *Dauceria* Dennst. ex Steud. (1840) is illegitimate.

Embelia Basaal (Roem. et Schult.) A. DC. is taxonomically distinct from *E. tsjeriam-cottam* (Roem. et Schult.) A. DC. as is evident from a reference to t. 12 vis-a-vis t. 11 in Rheed. Hort. Malab. 5 (1685). The former has oblong-rounded leaves with an acute apex, cauliflorous inflorescences, the racemes bearing two rows of flowers and fruits; the latter has oblong rounded leaves with obtuse apex and generally terminal racemes. A critical study of specimens in CAL shows that *E. Basaal* is characterised by oblong-rotund leaves with acuminate apex, reddish-green in colour, fine reticulations of the veins and veinlets, flaccid in texture; cauliflorous inflorescences, pedicellate flowers and fruits, is the more commoner of the two species and represents the *'Vidingi'* of the Ayurvedic literature. Unfortunately, however, many sheets representing the true *E. Basaal* have been identified as *'E. tsjeriam-cottam'*, presumably because these two species were considered conspecific by many authors (e.g. Clarke in FBI 3: 515. 1882; Cooke, Fl. Bomb. Presid. 2: 144. 1904). In fact, there is just one specimen in CAL (Nilgiri Distr. Maryland R. F. 10 Dec. 1957, *K. M. Sebastine* 4882) which is an exact match with Rheed. Hort. Malab. 5. tab. 11 with regard to leaf-shape etc. and represents *E. tsjeriam-cottam* rather than *E. Basaal* as wrongly annotated. While Wight, Icon. t. 1209 represents *E. tsjeriam-cottam,* Wight, l.c. tab. 1210 is *E. Basaal*; tab. 1208 represents *E. gerardiana* Wight and tab. 1591, *Samara rheedi* Wight; these two species are taxonomically quite distinct from *E. Basaal* — *E. tsjeriam-cottam* complex, as also from *E. villosa* Wall. Gamble (l.c.) therefore was in error in citing *E. viridiflora* Scheff. (as 'Clarke'), *Choripetalum aurantiacum* A. DC. and *Samara rheedii* Wight as conspecific with and synonymous to *E. Basaal* (Roem. at Schult.) A. DC. *E. viridiflora* represents a climbing shrub with coriaceous elliptic-obovate leaves narrowed at base, is very different from Wight Icon. Tab. 1210 representing *E. Basaal* and represents a species-group restricted to South India, Sri Lanka and Malaya (cf. Clarke, l.c.) and is absent from the mainland of India. Indeed, it appears that *E. tsjeriam-cottam* sensu Gamble, non (Roem. et Schult.) A. DC. represents *E. Basaal* (Roem. et Schult.) A. DC. More recently, Saldanha (1984) has correctly interpreted *E. Basaal* although he was unsure of the correct interpretation of *E. tsjeriam-cottam* based on Rheed. Hort. Malab.

5: t. 11 (1685). One of us (S.M.) suspects that the latter may not even belong to the Myrsinaceae and expects to undertake a thorough revision of this complex.

The nomenclatural set-up of *Embelia Basaal* is as follows:

Embelia Basaal (Roem. et Schult.) A. DC. in Trans. Linn. Soc. 17: 131. 1837; Graham, Cat. Bomb. Pl.: 104. 1839; Hasskarl in *Flora* 44 (Neus Beih. 19): 546. 1861; Saldanha, Fl. Karnataka 1: 348, 1984.

Ardisia? *Basaal* Roem. et Schult., Syst. Veg. 4: 517. 1819.

Type: "In Malabar et Cochinchina", Rheed. Hort. Malab. 5: t. 12, 1685.

Basaal Rheede, Hort. Malab. 5: 23, t. 12. 1685; Lamarck, Dist. Encycl. Bot. 1: 381. 1789 (as '*Basal* or *Basaal*').

Dauceria acuta Dennsted, Schules Zum Hort. Malab. 31. 1818, *nom. invalid* (cf. Manitz in *Taxon* 17: 500. 1968).

D. acuta Dennst. ex Steudel, Nom. Bot. 1: 485. 1840, *nom. illeg. superfl.*

Type: Same as for *Ardisia*? *Basaal* Roem. et Schult.

Basal acutipetalum Hassk., Horti Mal. Rheedeani Clavis: 40. 1867 (as 'Lamk, Encycl. 1: 381.1'), *nom. superfl. illeg.* Type: Same as for *E. Basaal* Roem. et Schult.

Embelia tsjeriam-cottam sensu Santapau, Fl. Khandala, ed. 3: 141. 1967, p.p. quoad syn, *E. Basaal*; Ramamoorthy in Saldanha and Nicolson, (ed.) Fl. Hassan: 202. 1976; sensu Gamble, Fl. Presid. Madras 2: 529, 1921; non (Roem. et Schult.) A. DC. (1837).

E. robusta auct. plur., non Roxb. (1820); e.g. Clarke in Hook. f., Fl. Brit. Ind. 3: 515. 1882, p.p. quoad *E. Basaal pro syn.*; Cooke, Fl. Bombay Presid. 2: 144. 1904 (reprint. 1958) p.p. quoad *E. Basaal pre syn.*

E. acutipetalum S. M. Almeida and M. R. Almeida, Journ. Bombay Nat. Hist. 81: 741. 1984 [as '(Lam. ex Hassk.), comb. nov.'] *nom. superfl. illeg.*

Type: Same as for *Ardisia*? *Basaal* Roem. et Schult.

Distribution: India, Burma.

SUMMARY

Embelia Basaal (Roem. et Schult.) A. DC. is established as the correct name for the widespread species, known as *'Vidingi'* in Ayurvedic literature and the involved nomenclatural problems in this species complex is discussed and sorted out.

BOTANICAL SURVEY OF INDIA,
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REFERENCE

ALMEIDA, S. M. AND ALMEIDA, M. R. (1984): 'Nomenclatural Notes on some Plants from Maharashtra', *Bombay nat. Hist. Soc. 81*: 741-743.

34. NEW TAXA OF *ANABAENA* BORY — THE BLUE GREEN ALGAE FROM PADDY FIELDS OF KARNATAKA STATE (INDIA)

(*With three text-figures*)

INTRODUCTION

Among a number of interesting algae recorded during our studies on the algal flora of crop fields, those belonging to *Anabaena* Bory of Nostocaceae: Nostocales: Cyanophyta (Desikachary 1959) are included in the present communication. Algae recorded in enrichment cultures of soil samples were further studied by isolating in soil-water biphasic media (Singh 1961).

1. **Anabaena oscillatoroides** Bory ex Born. et Flah. var. **attenuata** var. nov. (Fig. 1).

Thallus microscopic; trichomes short, slightly attenuated at ends; cells 3.0-3.5 μm broad, barrel shaped; end cell obtuse conical; heterocysts subspherical to compressed, 5.0-5.5 μm broad; spores cylindrical with rounded ends, 8-9 μm broad, 17-26 μm long.

Habitat: Paddy field soil at Mutnal in Belgaum district, Karnataka State.

Type specimen: Deposited (KUDB-76/42) at the Algal Laboratory, Karnatak University, Dharwad.

Anabaena oscillatoroides Bory ex Born. et Flah. var. **attenuata** var. nov. (Fig. 1)

Thallus microscopicus; trichomata brevia, in extremitatibus paululum attenuata; cellulae 3.0-3.5 μm lata, doliformes; cellula terminalis obtuse conica; heterocystes subsphaericae ad compressas, 5.0-5.5 μm lata; sporae cylindricae, extremitatibus rotundatis, 8-9 μm lata, 17-26 μm long.

Habitatio: in soli ex agro Oryzae ad locum Mutnal in Belgaum district of Karnataka State dictum relata.

Typus speciminis: in laboratorio pro Algis, Universitatis Karnatak, Dharwad (KUDB-76/42) depositus.

Differs from the type in the heterocysts being not oval and being smaller, and trichomes attenuated at the ends and smaller (Geitler 1932, p. 886, fig. 567; Desikachary 1959, p. 417, pl. 71, fig. 7).

Anabaena rivularioides sp. nov. (Fig. 2)

Thallus super superficiem soli patens; trichomata perlonga, diverse flexa, 3.5-4.0 μm lata, in vagina non inclusa; cellulae doliformes, circa 1½ plo longiores quam latae; proprie ad locos incrementi in partes longas capillares attenuatae et denique ad heterocystes se fragentes; heterocystes intercalares ovales ad ellipsoideas ad sub-quadratas, 6-7 μm lata, usque ad 10 μm long., heterocystes terminales subsphaericae ad sub-conicas, paulo minores quam cellulae vegetativae; sporae ellipsoideae, iuxta heterocystes intercalares et uno in latere, 5.0-6.5 μm lata, 7-8 μm long., epispora levis.

Habitatio: in soli ex agro Oryzae ad locum Mutnal in Belgaum district of Karnataka State dictum relata.

Typus speciminis: in laboratorio pro Algis, Universitatis Karnatak, Dharwad (KUDB-76/30) depositus.

2. **Anabaena rivularioides** sp. nov. (Fig. 2)

Thallus spreading on soil surface; trichomes very long, variously bent, 3.5-4.0 μm broad, not enclosed in a sheath; cells barrel shaped, about 1½ times longer than broad, characteristically attenuated into long hair like portions at growing points and finally breaking at heterocysts; intercalary heterocysts oval to ellipsoidal to sub-quadrate, 6-7 μm broad, upto 10 μm long; terminal heterocysts subspherical to subconical, slightly smaller than vegetative cells;

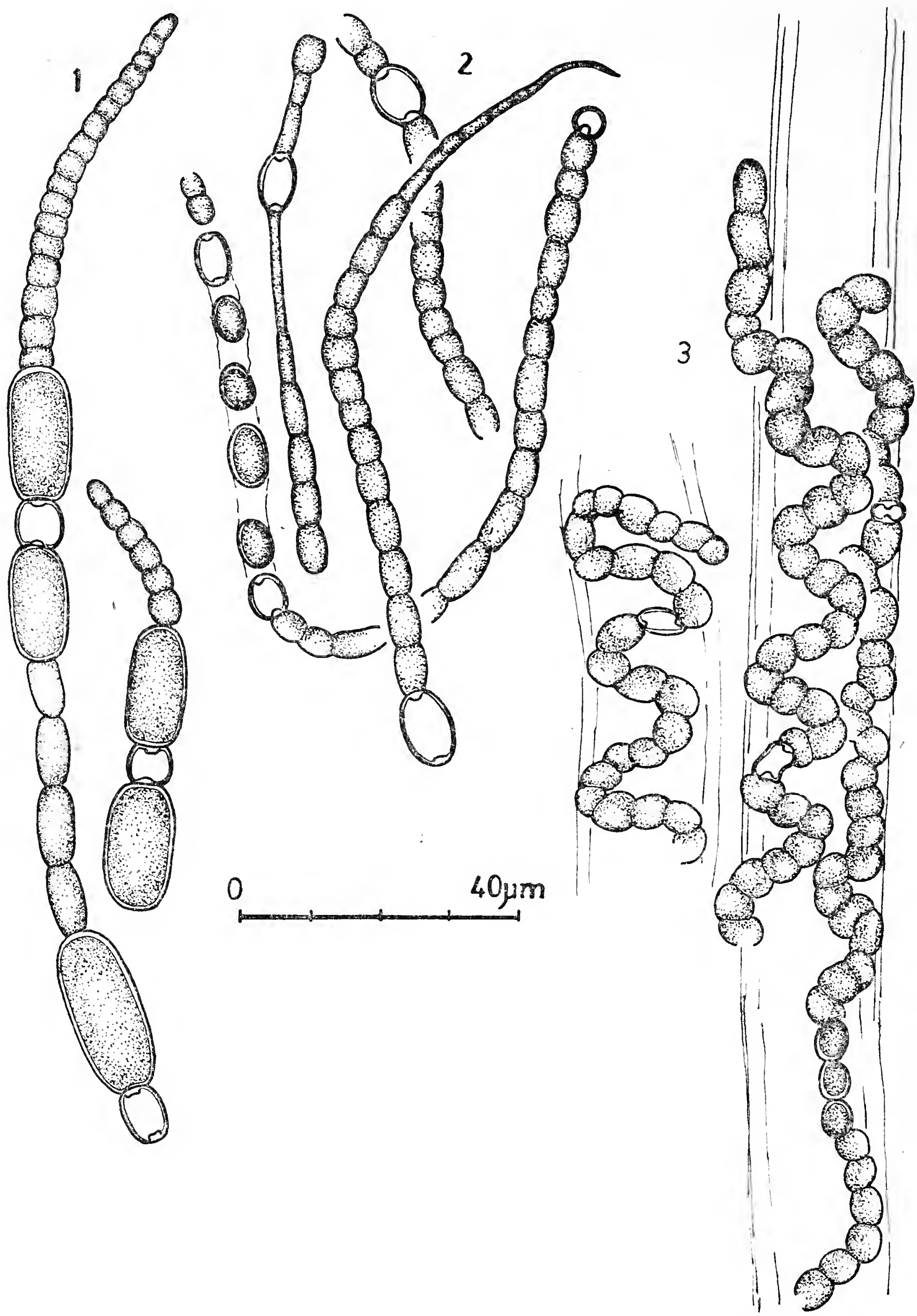

Fig. 1. *Anabaena oscillatoroides* Bory ex Born. et Flah. var. *attenuata* var. nov.
Fig. 2. *A. rivularioides* sp. nov.
Fig. 3. *A. spiroides* Klebahn var. *epiphytica* var. nov.

spores ellipsoidal, next to and on one side of intercalary heterocysts, 5.0-6.5 μm broad, 7-8 μm long, epispore smooth.

Habitat: Paddy field soil at Mutnal in Belgaum district of Karnataka State.

Type specimen: Deposited (KUDB-76/30) at the Algal Laboratory, Karnatak University, Dharwad.

The alga can be compared with *Anabaena aphanizomenoides* Forti, in the shape and size of vegetative cells and heterocysts (Geitler 1932, p. 875, fig. 556; Desikachary 1959, p. 405, pl. 71, fig. 4); but differs from in having terminal unipored heterocysts, smaller size of akinetes and in trichomes being occasionally tapering and breaking adjacent to the intercalary heterocysts giving an appearance of the filaments of *Rivularia* (Roth.) Ag. (!). In view of these distinctive characters, the present form is separated as a new species, the name being suggestive of its resemblance to *Rivularia.*

Anabaena spiroides Klebahn. var. **epiphytica** var. nov. (Fig. 3):

Trichomata 2-3 crescentia super vaginas vacuas mucilaginasque probiliter *Lyngbya* Ag., regulariter torsiva maximam partem, et erecta spatium breve in extremitate; spirae 15-20 μm latae, 9-22 μm distantes; cellulae 3-6 μm latae, cupiformes, usque ad 2-plo longiores quam latiores; cellula terminalis obtusa; heterocystae rarae, cylindricae depressaeque, 3.0-3.5 μm latae, 5-6 μm longae; sporae (iuvenes?) rarae, procul ab heterocystis, breves ellipsoideaeque, 4.0-4.5 μm latae, usque ad 5.5 μm longae, episporium laeve.

Habitatio: in soli ex agro Oryzae, Halyal, in regione Kanara septentrionali, Karnataka.

Typus speciminis: in laboratorio pro Algis, Universitatis Karnatak, Dharwad (KUDB-76/88) depositus.

3. **Anabaena spiroides** Klebahn. var. **epiphytica** var. nov. (Fig. 3)

Trichomes 2 to 3 together growing over empty mucilagenous sheaths probably of *Lyngbya* Ag. regularly spirally coiled for the major part and terminally errect for a short distance, spirals 15-20 μm broad and 9-22 μm distant; cells 3-6 μm broad, short barrel shaped to twice as long as broad; end cell obtuse; heterocysts rare, compressed cylindrical, 3.0-3.5 μm broad, 5-6 μm long, spores (young?) rarely found, away from the heterocysts, short ellipsoidal, 4.0-4.5 μm broad, upto 5.5 μm long, epispore smooth.

Habitat: Paddy field soil at Halyal in North Kanara district, Karnataka State.

Type specimen: Deposited (KUDB-76/88) at the Algal Laboratory, Karnatak University, Dharwad.

Differs from the type in trichomes being not single and free floating, spirals being more compact, heterocysts being not sub-spherical and spores not spherical (Geitler 1932, p. 881; Desikachary 1959, p. 395, pl. 71, fig. 9).

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35. VARIABILITY IN *BALANITES ROXBURGHII* PL. IN THE INDIAN DESERT

Introduction

Morphological variability in fruit and seed has some adaptive value for plants in different habitats. Polymorphism is an adaptive trait in arid environment which is characterised by extremes of temperature, low erratic and variable rainfall, high evaporation rates and different soil types. Such variable stress conditions and gene exchange through cross pollination have generated more variability. This desert region is also a centre of diversity/origin of crops like *Vigna acontifolia, Cyamopsis tetragonoloba, Zizyphus mauritiana* and *Carissa congesta* (Singh *et al.* 1963).

Balanites aegyptiaca Del. is thought to have originated in Nile valley, but is now widely distributed in Africa and Asia (Davis *et al.* 1983). The Indian plant *B. roxburghii* Pl. has a wide ecological amplitude and is common all over western Rajasthan except in the extreme north western part of the state where the annual rainfall is below 200 mm. Its fruits are a source of diosgenin, a precursor for the synthesis of sex hormones, cortico-steroid drugs, anabolic agents and anti-fertility compounds. The seeds contain about 45% oil and seed meal with high amount of protein. The study of the ecological distribution of the plant in western Rajasthan has led to the collection and identification of 50 types from ten sites located in four districts. The type was based on the fruit shape and size. The leaves were also collected to find if correlation exists between shape/size of fruit and leaf.

Material and Methods

An exhaustive survey was conducted in the districts of Sirohi, Pali, Jodhpur, Barmer and Jaisalmer, to collect fruit and leaf material from *Balanites* trees. At least 20 fruits and leaves were collected from each tree. Observations were recorded on fruit weight, length, width, circumference, volume, weight, length, width of stone and seed (after removal of pulp and endocarp) and leaflet length and breadth. The mean, standard deviation and coefficient of variation values were estimated for each character observed. Correlation analysis was done for length, breadth, size index and shape index characters of fruit and leaflet. Length × breadth gave size index while length divided by breadth gave shape index.

Results and Discussion

Among an exhaustive collection of fruits from several sites, at least fifty types have been identified based on fruit characters. A great amount of variability with respect to fruit length, width, circumference, weight, volume and diosgenin content existed (Table 1). The size and shape of the stone and seed resembled to that of the fruit. The size and shape of the leaflets of the fifty types also

exhibited variation. The estimation of standard deviation and co-efficient variation showed existence of considerable variation in the observed characters. Volume followed by weight of fruit revealed the highest coefficient of variation and fruit width the lowest. In case of leaflet, length exhibited a lower variation coefficient compared to breadth (Table 2). A particular type of fruit may occur in different sites. For example, long fruits are seen to occur in almost all locations. Dhola (Pali dt.) had the maximum number of types (Table 2A) Sucker-propagated trees bore the same type of fruits of the parent tree. Hence, the existing variability is genotypic. The species is also cross pollinated, by insects. It is such genetic variability that provides a rich assortment of biotypes bringing more microsites into the ecological amplitude of the species. *Balanites* is distributed from a sub-humid area (Abu-Kozra) in extreme south to arid areas (Balotra, Osian).

TABLE 1

RANGE OF VARIATION IN FRUIT SIZE AND SHAPE AND DIOSGENIN CONTENT IN FRUIT PULP

Parameter	Range
Length	2.6–8.2 cm
Width	2.2–6.3 cm
Circumference	7.0–19.4 cm
Weight	6.0–80.0 g
Volume	5 –106 cc.
Diosgenin content	0.1–5.6 %

TABLE 2

VARIABILITY ANALYSIS OF FRUIT AND LEAF CHARACTERS OF THE 50 TYPES

Characters		Mean	SD	CV %
Fruit	Weight (g)	27.53	12.27	44.56
	Length (cm)	4.97	1.07	21.48
	Width (cm)	3.72	0.67	18.03
	Size index	18.71	5.87	31.37
	Shape index	1.36	0.35	25.59
	Circumference (cm)	11.78	2.07	17.58
	Volume (cc)	34.46	18.64	54.09
Leaf	Length (cm)	3.45	0.65	18.93
	Breadth (cm)	1.67	0.45	26.84

TABLE 2A

LOCATIONAL SOURCE OF THE TYPES DESCRIBED

Type code	Location	District
01-07	Devlia	Jodhpur
08-09	Luni	,,
10-13	Pal	,,
14-20	Osian	,,
21-24	Kailana	,,
25-	Megalasiya	,,
26-28	Balotra	Barmer
29-37	Dhola	Pali
38-43	Sheoganj	Sirohi
44-50	Sirohi	,,

In *Citrullus colocynthis,* Pareek and Vashishtha (1980) reported a great amount of variability in fruit volume, seed number per fruit, per seed weight and oil content in this region. Seed variability has been recorded in *Crotalaria medicaginea* (Bohra and Sen 1974) and diversity in size, weight and number of seeds in *Cucumis callosus* (Bansal and Sen 1978).

Statistically, highly significant correlation has

TABLE 3

CORRELATION BETWEEN LEAF AND FRUIT CHARACTERS

Characters (Leaf VS fruit)	Correlation coefficient
1. Length	0.56**
2. Breadth	0.57**
3. Size Index	0.54**
4. Shape index	0.45**
(** highly significant at 1% level)	

been established between leaf and fruit characters (Table 3). Correlation coefficient was highest with respect to breadth and lowest in case of shape index.

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36. ADDITIONAL REPORTS OF THE ASTERACEAE FOR PUNJAB STATE

Nair (1978), in his most recent and comprehensive work dealing with the Punjab plants, has recorded 62 wild and 6 cultivated species of the Asteraceae. Subsequently, Daniel (1982) reported *Glossocardia bosvallea* (Linn. f.) DC. from Garhimanswal (Dist. Hoshiarpur). Based upon the plant explorations of Punjab for seventeen years (1963-1979), I enumerated another 16 wild (Sharma 1982a) and 41 cultivated species (Sharma 1982b) of the Compositae from Punjab State. Further collections and observations for six years (1980-1985) from the unexplored and underexplored Shivaliks and submountainous zone of this area have resulted in the recording of another 8 species listed below alphabetically with some relevant observations and annotations. All the specimens cited here are deposited in Herbarium Punjabi University, Patiala (PUN).

1. **Adenostemma lavenia** (Linn.) O. Kuntze, Rev. Gen. Pl. 1 : 304. 1891; Raizada, Suppl. Fl. Upp. Gang. Plain 100. 1976; Babu, Herb. Fl. Dehra Dun 237. 1977. *Verbesina lavenia* Linn. Sp. Pl. 902. 1753. *Adenostemma viscosum* J. G. Forst. Char. Gen. Pl. 90. 1776; Hook. f. Fl. Brit. Ind. 3: 242. 1881, *pro parte.*

Occasionally met with in marshes on the northern side of the State particularly towards Shivaliks. This species is characterized by 1-1.5 mm long corolla, 5-6 mm long heads, 3-4 mm long involucre and tuberculate achenes. Hooker (loc. cit.) had described seven varieties under *A. viscosum.* Plants from our area are referable to var. *parviflorum* (Bl.) Hook. f. However, Hooker (loc. cit.) reduced *A. micro-*

phyllum (Bl.) DC. to the synonymy of this variety. Priestly, *A. microphyllum* is treated as a distinct species (Raizada, Babu loc cit.). It has larger corolla (2.5-3 mm long), heads (8-10 mm long), involucre (5-6 mm long) and smooth achenes in contrast to those of *A. lavenia.*

Fl. & Fr.: September-November.

Specimens examined: Chamkaur Sahib Ropar Headworks, Amritsar; *M. Sharma* 10433, 10487, 11740.

2. **Bidens bipinnata** Linn. Sp. Pl. 832. 1753; Sherff, Field. Mus. Nat. Hist. Bot. 16: 366. 1937; Dakshini & Singh, Proc. Ind. Acad. Sci. (Pl. Sci.) 93: 175. 1984.

Common locally in shady waste lands towards Shivaliks.

Fl. & Fr.: July-November.

Specimens examined: Morinda, Bela; *M. Sharma* 10461, 10484.

3. **Coreopsis basalis** (A. Dietr.) Blake, Proc. Amer. Acad. 2: 525. 1916; Bailey, Man. Cult. Pl. 1003. 1949. *Calliopsis basalis* A. Dietr. in Otto & Dietr. Allgem. Gartenz. 3: 330. 1835

A native of North America. Commonly cultivated, often found as an escape near gardens.

Fl. & Fr.: February-April.

Specimens examined: Univ. Campus, Patiala; *M. Sharma* 819, 883.

4. **Coreopsis lanceolata** Linn. Sp. Pl. 908. 1753; Bailey, Stand. Cycl. Hort. 1: 845. f. 1056. 1928; Man. Cult. Pl. 1003. 1949; Vishnu Swarup, Garden Fl. 146. 1967.

A native of North America. Commonly grown as a garden ornamental. Occasionally also found as a self-sown near gardens.

Fl. & Fr.: February-April.

Specimens examined: Univ. Campus, Patiala, *M. Sharma* 11738.

5. **Filago pyramidata** Linn. Sp. Pl. 1199. 1753; Stewart, in Nasir & Ali, Fl. W. Pak. 747. 1972; Holub in Davis, Fl. Turkey 5: 104. 1975; in Tutin *et al.* Fl. Europ. 4: 122. 1976. *F. spathulata* Presl, Delic. Prag. 99. 1822; Nair, Fl. Bashahr Himal. 152. 1977. *F. germanica auct.* non Linn.; Hook. f. Fl. Brit. Ind. 3: 277. 1881.

Common in sandy areas along the foot-hill zone of the State. In Indian taxonomic literature, this species has often been described under the name *F. germanica* Linn. (correct name *F. vulgaris* Lam.) which is characterized by linear — lanceolate to lanceolate leaves and heads in clusters of 20-40. In the present taxon, the leaves are obovate-oblong or spathulate and heads in clusters of 5-20.

Fl. & Fr.: March-May.

Specimens examined: Samana, Bhankarpur, Ropar, Nangal, Nurpur Bedi; *M. Sharma* 3249, 3518, 5653, 8503, 10428.

6. **Siegesbeckia orientalis** Linn. Sp. Pl. 900. 1753; Hook. f. Fl. Brit. Ind. 3: 303. 1881.

This species has been observed in the submountainous zone of the State and appears to be a recent introduction from the hills where it grows in W. Himalayas up to an altitude of 1,800 m. The plant is recognized easily because of its sticky, glandular involucral bracts.

Fl. & Fr.: August-November.

Specimens examined: Nangal, *M. Sharma* 10325.

7. **Silybum marianum** (Linn.) Gaertn. Fruct. Sem. 2: 378. t. 168. 1791; Hook. f. Fl. Brit. Ind. 3: 365. 1881. *Cardus marianus* Linn. Sp. Pl. 823. 1753.

Common in and around Pathankot and elsewhere in Dist. Gurdaspur in waste land. This thistle-like herb is easily recognized because of

its crispy, spinescently dentate leaves with broad pale midrib and 4-5 cm long heads surrounded by prominently spine-tipped involucral bracts.

Fl. & Fr.: March-May.

Specimens examined: Pathankot, *M. Sharma* 13598.

8. **Ursinia anethoides** (DC.) N. E. Br. Gard. Chron. 1: 670. 1887; Bailey, Man. Cult. Pl. 1013. 1949; Vishnu Swarup, Garden Fl. 133. 1967. *Sphenogyne anethoides* DC. Prodr. 5: 685. 1836.

A native of South Africa. Often grown in gardens.

Fl. & Fr.: February-April.

Specimens examined: Univ. Campus Patiala, *M. Sharma* 11737.

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37. LIMNOLOGICAL INVESTIGATION IN THE BACK-WATER LAGOON OF GOPALPUR-ON-SEA

(*With two text-figures*)

INTRODUCTION

Around 2 Km^2 area of Gopalpur-on-Sea is periodically flooded by sea water through a back-water-lagoon. Since the sewage and muninicipal canals are directed to this low-lying back-water lagoon, it is often rich with various nutrients that encourages growth of various organisms. Although a limited amount of floristic work dealing with algae had been made in the past (Pattnaik *et al.* 1979) attention had not been given to study the limnological aspects of the habitat. The present investigation was carried out to study the water quality, variation in the quantity and quality of phytoplankton during different seasons and the

general vegetation type of the back-water lagoon of Gopalpur-on-Sea.

The Experimental Site

The experimental site of around 2 Km^2 area was at Gopalpur-on-Sea (19°16′N, 84°55′E) on the coastal belt of the Bay of Bengal (Fig. 1). The soil is characterized by high proportion of sand and poor water retention. The climate is monsoonal with three distinct seasons: Summer (March-June), rains (July-October) and winter (November-February). The total rainfall for 1983 was 1200 mm of which 70% fell in the wet season. The mean monthly maximum and minimum temperatures ranged from 28°C (January) to 33°C (May) and 18°C (January) to 26°C (May) respectively. The low lying back-water lagoon of variable depths, rich with aquatic vegetation only during certain period of year, was greatly influenced by the municipal sewage and periodic influx of sea water. The shallow region of the low lying area generally dry up during late winter and summer.

Methods

Limnological studies were made for the first time in the back-water lagoon of Gopalpur-on-Sea during three different seasons between November, 1983 and September, 1984. Samples and field data were taken from three different stations in the area in each trip. Temperature was recorded on the spot with a mercury thermometer graduated upto 100°C. The hydrogen-ion-concentration was determined using a digital pH meter. Water samples were analysed for the presence of various chemicals according to the methods described in the standard methods for examination of water and waste water (American Public Health Association 1971). Chlorophyll determination was based on the method of Talling & Driver (1961). From each spot duplicate water samples of 500 ml. each were filtered through 47 mm Millipore H. A. filters with pore size of 0.45 μm. The optical density was measured using an Erma (Japan) spectrocolorimeter. Samples of planktons were collected by filtering known quantity of water taken from different spots of the study site through a plankton net made of standard bolting silk cloth (No. 21 with 77 meshes/sq. cm.). The concentrated plankton was preserved in 4% formalin and determined qualitatively and quantitatively by sedimentation and drop count method. Various phytoplanktons were identified according to Fritsch (1945) and Desikachary (1959).

Results and Discussion

Table 1 shows the different physico-chemical parameters of the water from three different spots of the low lying back-water lagoon of Gopalpur-on-Sea in three different seasons of a year. Fig. 2 shows the comparative size of phytoplankton belonging to different groups of algae during the above investigation period. Phytoplankton count showed that the green algae were dominant planktors followed by blue-green, diatoms and euglenoid algal members in almost all the seasons. However, the total number of planktons were significantly reduced during rainy season. This may be due to constant influx of rain and sea water to the lagoon which decreases the concentration of most of the inorganic chemicals (Table 1).

During rainy season a number of *Ectocarpus* sp. commonly occur in the sea water (Pattnaik *et al.* 1979) found growing in the back-water lagoon. However, during winter and summer, *Cladophora* and *Polysiphonia* species were found to be dominant attached forms indicating that the algal flora of the lagoon resembled that of lotic environment.

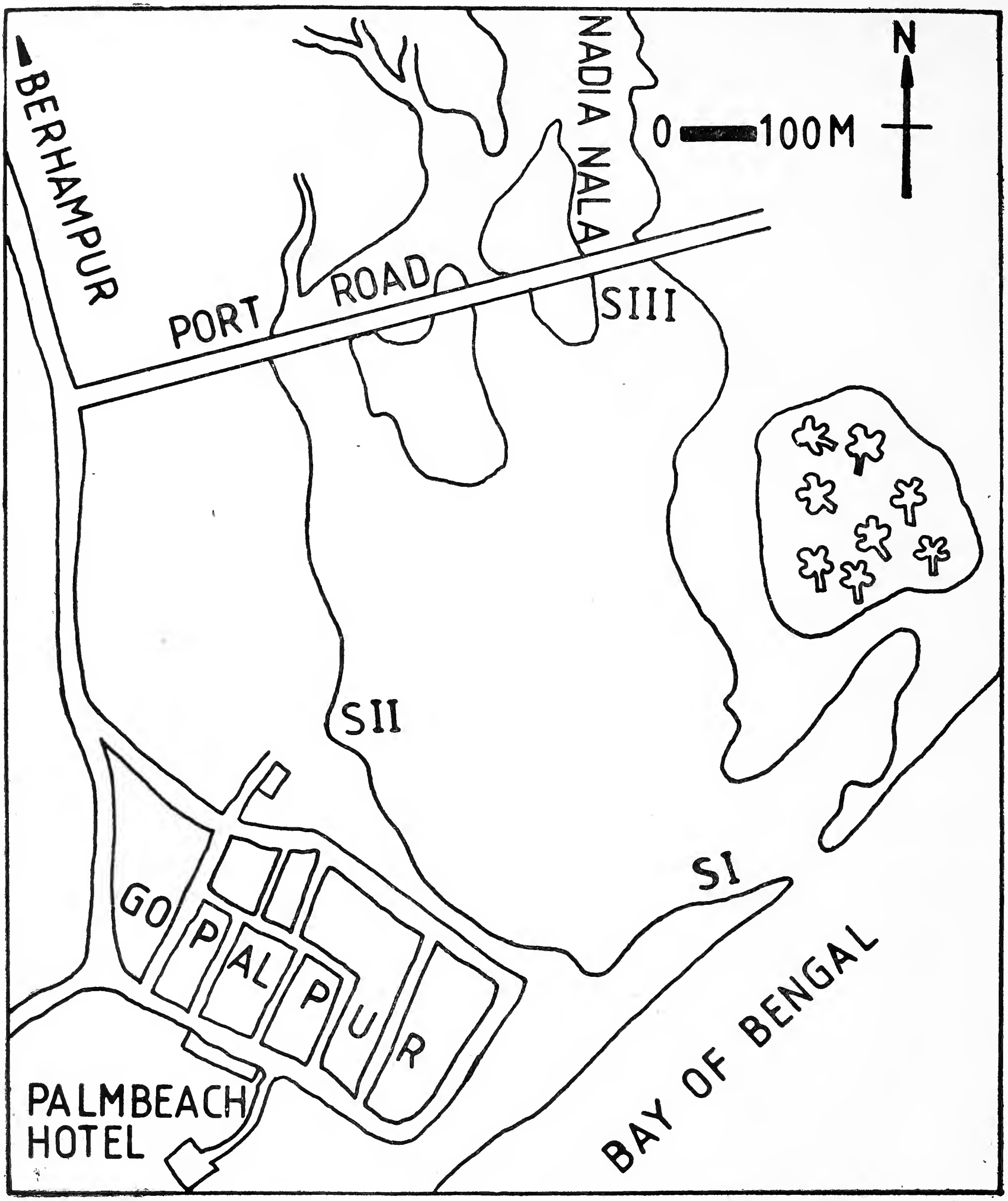

Fig. 1. Area map of the back-water lagoon of Gopalpur-on-Sea.

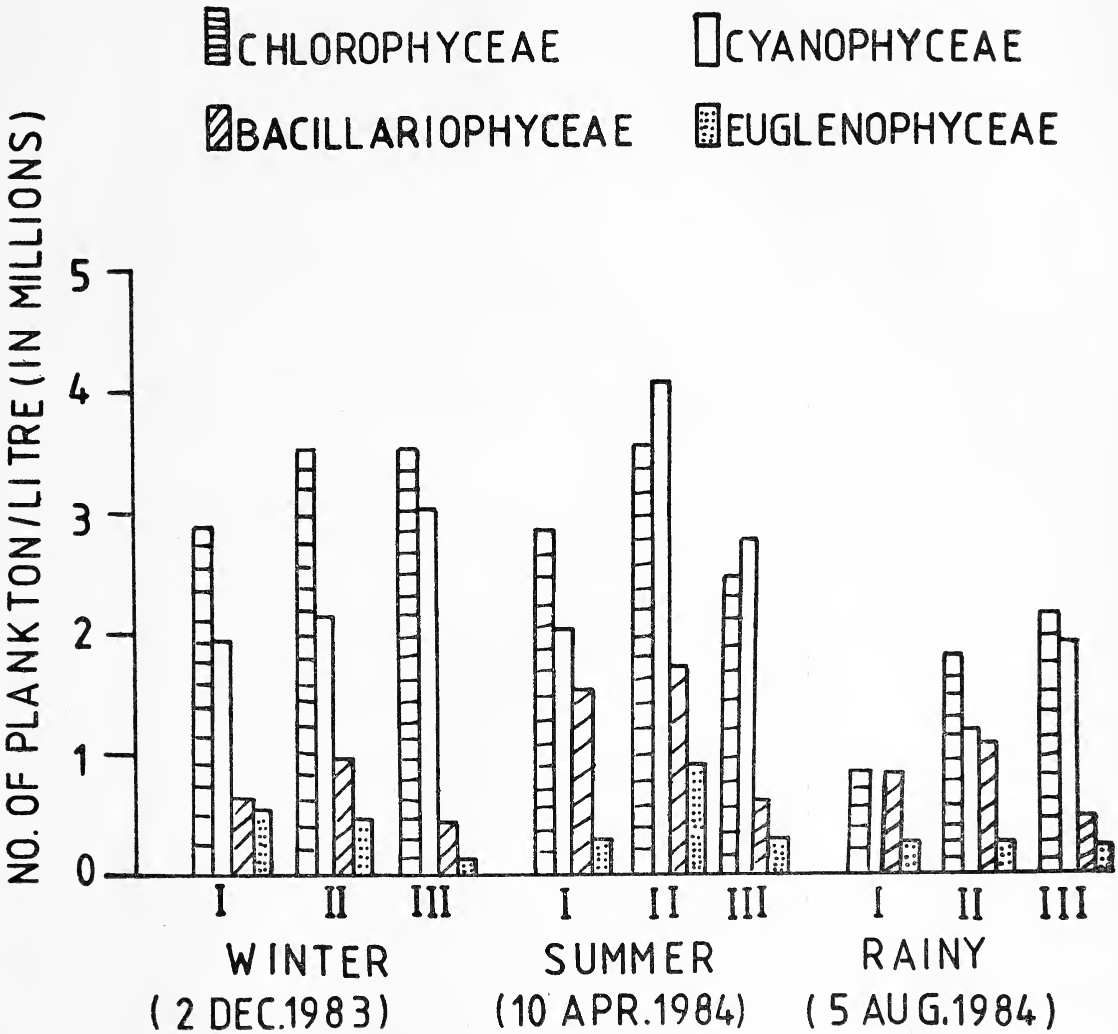

Fig. 2. Histograms showing the comparative size of phytoplankton belonging to different groups of algae occurring in the back-water lagoon of Gopalpur-on-Sea during three different seasons of a year.

The various algal species occurring in different sites of the study area are summerized in Table 2.

In addition to the algal forms, a number of aquatic angiosperms also occur in the back-water lagoon. Mixed vegetation of *Typha domingensis* Pers. (*T. anustata* Bory et Chaulo) and *Phragmites australis* (Cav.) Trin. ex Steud. (*P. communis* Trin.) was commonly noted in the shallow areas of the lagoon during winter and summer season. *Ceratophyllum demersum* L. was the dominant submerged hydrophyte

TABLE 1

PHYSICO-CHEMICAL PARAMETERS OF THE BACK-WATER LAGOON OF GOPALPUR-ON-SEA AT THREE DIFFERENT SEASONS

Parameter	2nd December 1983 (winter)			10th April 1984 (summer)			5th August 1984 (rainy)		
	Spot			Spot			Spot		
	I	II	III	I	II	III	I	II	III
Temperature°C	25	25	25	29.5	29.5	29.5	26.5	26.5	26.5
Depth (meter)	0.5	2.2	muddy	0.2	1.8	muddy	1.2	3.6	0.4
pH	8.7	8.5	8.1	8.2	8.2	8.0	9.2	9.2	8.9
Carbon dioxide (mg/l)	2.5	4.0	4.0	2.5	4.5	3.0	3.2	3.5	2.5
Dissolved oxygen (mg/l)	5.4	5.6	3.8	4.4	4.4	2.8	4.2	4.6	5.2
Bicarbonate alkalinity									
(mg $CaCO_3$/l)	180.0	180.0	140.0	180.0	200.0	130.0	170.0	150.0	150.0
Salinity (%)	0.38	0.38	0.36	0.38	0.36	0.32	0.42	0.42	0.36
Ammonia (mg NH_3- N/l)	0.12	0.16	0.1	0.15	0.15	0.08	0.04	0.04	0.08
Nitrate (mg NO_3 N/l)	1.15	1.15	0.7	1.65	1.65	0.7	0.6	0.6	0.75
Nitrite (mg NO_2- N/l)	0.004	0.004	0.002	0.004	0.005	0.002	0.001	0.001	0.002
Phosphate (mg PO_4/l)	0.42	0.45	0.35	0.42	0.42	0.28	0.4	0.4	0.3
Silicate (mg SiO_2/l)	7.8	8.2	2.5	7.5	7.8	6.0	8.5	8.5	5.2
Sulphate (mg SO_4/l)	120.0	120.0	38.0	118.0	110.0	24.0	115.0	120.0	98.0
Chlorophyll-a (mg/l)	2.18	6.64	7.82	8.85	10.55	3.54	0.88	1.25	1.86

TABLE 2

OCCURRENCE OF VARIOUS ALGAL MEMBERS IN THE BACK-WATER LAGOON OF GOPALPUR-ON-SEA DURING THREE DIFFERENT SEASONS

Organism	2.12.1983 (winter)			10.4.1984 (summer)			5.8.1984 (rainy)		
	Spot			Spot			Spot		
	I	II	III	I	II	III	I	II	III
CYANOPHYCEAE:									
Microcystis protocytis Crow.	–	+	+	+	+	+	–	+	+
Aphanothece bullosa Menegh.	+	++	+	+	++	+	+	++	++
Chroococcus minutus Kütz. ex Näg.	–	+	+	+	++	–	+	++	–
Chroococcus turgidus Kütz. ex Näg.	–	+	+	+	+	–	–	–	+
Gloeothece palea Kütz. ex. Rabenhorst	–	+	–	–	+	–	–	–	–
Spirulina major Kütz. ex Gomont	–	+	+	+	++	–	–	–	+
Oscillatoria annae Goor	+	+	–	–	+	–	–	–	+
Oscillatoria ornata Kütz. ex Gomont	–	+	–	+	++	+	–	+	+
Oscillatoria rubescens DC. ex Gomont	–	+	+	+	+	+	–	–	+
Phormidium fragile Gomont	–	+	+	+	+	–	–	–	–
Gloeotrichia intermedia Lamm.	–	–	+	+	+	–	–	–	+
Scytonema schmidlei De. Toni.	–	–	+	–	+	–	–	–	–
Merismopedia minima Beck.	+	+	–	+	++	–	+	+	+
CHLOROPHYCEAE:									
Chlorococcum humicola Näg. ex Rabenh.	–	+	–	+	+	–	–	–	–
Pediastrum simplex Meyen.	–	+	–	+	+	–	–	–	+
Tetrahedron muticum Hansg.	+	+	–	+	+	–	+	+	+
Draparnaldiopsis indica Singh	–	+	–	+	+	–	–	–	+
Cladophora rupestris (L.) Kütz.	+	++	+	++	++	+	+	++	++
Ulothrix flacca (Dillw.) Thur.	++	++	+	+	+	+	+	++	++
Ulva lactuca L.	+	+	+	+	+	+	–	–	+
Enteromorpha clathrata (Roth.) Grev.	+	+	–	–	+	–	+	+	+
Cosmarium laeve Rabenhorst	+	++	–	–	+	–	+	+	+
Cosmarium granatum Brebisson	+	+	–	+	+	–	–	+	+
Euestrum spinulosum Delp.	+	+	–	+	+	–	–	–	–
BACILLARIOPHYCEAE:									
Fragilaria intermedia Grun.	+	+	–	–	+	–	–	–	–
Gomphonema constrictum Ehr.	+	+	–	–	+	–	–	–	+
Navicula mutica Kütz.	+	++	–	–	++	+	+	++	+
Navicula radiosa Kütz.	+	++	+	++	++	+	+	++	+
Pinnularia braunii Grun.	+	+	–	–	+	–	–	–	+
Nitzschia communis Rabenhorst	+	+	–	+	+	–	+	+	+
EUGLENOPHYCEAE:									
Euglena gracilis Klebs.	+	+	–	+	++	–	+	+	+
Astasia fritschii Fritsch.	+	+	–	+	+	+	–	–	–
XANTHOPHYCEAE:									
Vaucheria compacta Coll ex Taylor	+	+	–	–	+	–	+	++	–
PHAEOPHYCEAE:									
Ectocarpus siliculosus (Dillw.) Lyngb.	+	–	–	–	+	–	++	++	–
Fucus serratus L.	+	+	+	–	–	+	–	–	+
RHODOPHYCEAE:									
Polysiphonia elongata (Huds.) Spreng.	–	+	+	+	+	–	–	+	–

+, Present; ++, Occur abundently; –, absent.

of this area. In addition, a number of other hydrophytes, viz. *Cyperus* spp., *Vallisneria spiralis* L., *Potamengeton orispus* L., *Utricularia* spp., *Ranunculus* spp. and *Polygonum* spp. also commonly occur around the study area.

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38. ADDITIONS TO THE PTERIDOPHYTIC FLORA OF KUMAUN AND NAINITAL (WESTERN HIMALAYA)

Duthie (1906) was the first to catalogue the Pteridophytic flora of Kumaun upto to the frontiers of Garhwal, Tibet and Western Nepal. He recorded a total of 185 species of ferns belonging to 30 genera and 15 species of fern — allies spread over 6 genera based on the collections made by Strachey and Winterbottom during the year 1946-1849. Later, Loyal & Verma (1960), Pande (1972), Verma & Khullar (1980) and Pangtey *et al.* (1982) made significant contributions to the fern flora of Kumaun Himalaya. Further, Dhir (1980) made the most comprehensive study on the fern flora of North-Western Himalaya from Kumaun to Kashmir based on his collections and earlier collections housed in different herbaria of India.

During the course of explorations of Pteridophytic flora of Kumaun and Naini Tal. 7 species of ferns and one species of fern allies were found to be new to the Pteridophytic flora of Kumaun. Among these 7 species, 4 species of ferns, i.e. *Polystichum prescottianum* (Wall. ex Mett.) Moore var. *castaneum* Clarke, *P. wilsonii* Christ., *Cystopteris dickieana* R. Sim. and *Pronephrium penangianum* (Hook.) Holtt. are new records for Kumaun. While *Selaginella involvens* (Swartz) Spring, *Polystichum*

manmeiense (Christ) Nakaike and *P. piceo-paleaceum* Tagawa are new to the Pteridophytic flora of Naini Tal as well as Kumaun and three species of ferns, viz. *Athyrium flabellulatum* (Clarke) Tard-Blot, *A. puncticaule* (Bl.) Moore and *Dryopteris wallichiana* (Spreng.) Hyl. are new additions to the fern flora of Naini Tal. A perusal of earlier published records and herbaria indicate that these species have neither been collected nor reported so far from Kumaun and Naini Tal. This note, therefore, records the additions of these species to the Pteridoyphytic flora of Kumaun and Naini Tal with other relevant informations. Voucher specimens are housed in the Herbarium, Botany Department, D.S.B. College, Kumaun University, Naini Tal.

SELAGINELLACEAE

1. **Selaginella involvens** (Swartz) Spring, Bull. Sci. Brux. 10: 136. 1843.

Status: Occasional on moist-wet rocks. Plants curl into a ball like mass during the dry season.

Specimen examined: PITHORAGARH DISTRICT: near Thal and Tawaghat; NAINI TAL DISTRICT: near Bajoon, Chanfi and Patuwadangar (YPSP 73, 341, 342, 464, 550, 558).

ASPIDIACEAE

2. **Dryopteris wallichiana** (Spreng.) Hyl., Blot. Notis. 352. 1953.

Status: A high altitude species, commonly growing in the valleys of Kumaun Himalayas between 2,500-2,900 m under the shade of large bushes with a basket like habit. However, this species has recently been collected from Naini Tal, where it was found growing on moist and dark shaded situations and is extremely rare.

Specimens examined: NAINI TAL: near Pangote (YPSP 504).

3. **Polystichum manmeiense** (Christ.) Nakaike, Misc. Publ. Nat. Sci. Mus. Tokyo 141. 1982

Status: Rather rare, usually grows in very moist and wet rocks along the streamlets in and around 1,800 m.

Specimens examined: NAINI TAL DISTRICT: near Kilberry (Naini Tal), (YPSP 277, 278, 494, 495).

4. **P. piceo-paleaceum** Tagawa, Acta Phytotax. Geobot. 5: 255. 1936.

Status: Quite common around Naini Tal between 1,800-1950 m in moist-shaded forest floors, roadsides and rock crevices.

Specimens examined: NAINI TAL DISTRICT: around Naini Tal, way to Kilberry, behind snow view and near Pangote (YPSP 295, 299, 527, 529, 530, 533, 570).

5. **P. prescottianum** (Wall. ex Mett.) Moore var. **castaneum** Clarke, Trans. Linn. Soc. Lond. 2(Bot.) 1: 510. 1880.

Status: Frequent on open and exposed forest floors between 2,800-3,300 m around timber line.

Specimens examined: ALMORA DISTRICT: between Dwali to Phurkia (YPSP 93, 95).

Note: This taxon differs from *P. prescottianum* (Wall. ex Mett.) Moore, in having darker coloured and more prominently bicolourous scales on rachis and stipe and lamina being usually narrower.

6. **P. wilsonii** Christ., Bot. Gaz. 51 : 353. 1911.

Status: Frequent among rocks and rocky habitats between 2,900-3,300 m in and around timber line.

Specimens examined: ALMORA DISTRICT: between Dwali to Phurkia *en route* to Pindari Glacier (YPSP 90, 101).

ATHYRIACEAE

7. **Athyrium flabellulatum** (Clarke) Tard-

Blot, Aspl. du Tonkin 81. t. 12. 1932.

Status: Extremely rare and grows on moist and humus rich forest floors along water courses between 1,600-1,800 m.

Specimens examined: NAINI TAL: near Dhobi Ghat (YPSP 537, 538, 539).

8. **A. puncticaule** (Bl.) Moore, Ind. Fil. 186. 1860.

Status: Rather rare but locally frequent near Pangote and Dhobi Ghat. Usually grows on moist and wet rocks near water courses in deep-shady ravines around 1,600-1,800 m.

Specimens examined: NAINI TAL: near Pangote and Dhobi Ghat (YPSP 542, 543).

9. **Cystopteris dickieana** R. Sim., Gard. Fram. Journ. ser. 2: 308. 1848.

Status: Infrequent between 2,000-3,300 m in rock crevices and shady-moist places.

Specimens examined: ALMORA DISTRICT: between Dwali to Phurkia *en route* to Pindari Glacier (YPSP 87).

THELYPTERIDACEAE

10. **Pronephrium penangianum** (Hook.) Holtt. Blumea 20: 110. 1972.

Status: Quite frequent near wet and open places especially recently cut slopes in Ramganga and Gori valleys upto 1,600 m.

Specimens examined: PITHORAGARH DISTRICT: Ramganga and Gori valleys (YPSP 68).

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39. ON THE OCCURRENCE OF FEW LITTLE KNOWN PLANT SPECIES FROM GARHWAL HIMALAYA

(*With two text-figures*)

The Himalayan region is enriched by several rare and important plant species, from the alpine meadows to the lower mountainous parts. Since the time of Strachey and Winterbottom (1882) the floristics of this important phytogeographic region has been worked out by various workers, viz. Smythe (1938), Ghildiyal (1957), Rau (1961), Naithani (1984), Semwal and Gaur (1981), Sharma and Gaur (1983), Negi *et al.* (1985) and others, specifying our knowledge of the plants from different pockets of the Himalayas.

The present paper highlights the recent occurrence and distribution of a few little known plant species, collected from Dudhatoli region of Garhwal Himalaya during 1983-1986. The perusal of literature showed that the species namely *Galium cryptanthum* Hemsl. (Rubiaceae), *Euphorbia peples* Linn. (Euphorbiaceae) and *Glyceria tonglensis* Clarke (Poaceae) are new additions to the flora of Garhwal. A brief description of the species, figures of some parts, flowering-fruiting periods, including recent distribution in the region follows.

Galium cryptanthum Hemsl. Hook. Icon. Pl. t. 1469; 1883, Collet. Fl. Sim. 236, Nair Fl. Bash. Him. 132, *G. vernum* Scop. Hook. f. FBI. 3: 209; 1881. Perennial herb, stem slender, 4 angled, weak, trailing, 15-30 cm, softly hairy, hairs reflexed. Leaves in whorls of 4, shortly stalked, ovate-lanceolate, 3 nerved from the base, hairy on margins and nerves, 0.5-1.6 cm by 0.3-0.6 cm, thin. Peduncles horizontal, axillary, 1-1.5 cm long. Bracteoles small, ovate, 0.5 by 0.3 cm. Pedicles very short. Flowers few, pale-white, 0.15 cm in dia., petals short, lanceolate. Fruit black, ovoid, smooth, 0.1 cm long

Distribution: In open shaded places, Dudhatoli area (on way to Kodiabagarh, 2700 m, Sept. 1985. GUH. 6501.

Flowering-Fruiting: August-September.

Glyceria tonglensis Clarke Journ. Linn. Soc. 15: 119; 1876, Hook. f. FBI. 7: 346; 1897, *G. caspica* Griseb. Goett. Nachr. 76; 1868, Collet. Fl. Sim. 628; 1902, Duthie. Cat. Pl. Kum. 218; 1906. Annual herb, stem slender, 30-80 cm, ascending, basal portion decumbent, creeping in wet places. Leaves 8-20 cm by 0.2-0.4 cm., flat, tip obtuse, sheeth glabrous. Ligule membranous, short, blunt, erect at the base. Panicles loose, variable insize. 10-15 cm long, rachis slender, 3-6 cm long. Spikelets few awnless, pale-green, glabrous, 1-1.5 cm., usually 4-5 flowered. Empty glumes 2, shorter than flowering glumes, the lower one much smaller, translucent, 0.1 cm long, the upper one 0.35 cm long. Fertile glumes 0.4-0.5 cm long. stiff, margins and tip hayline, ovate-oblong, prominently 7 nerved. Stamens 3. Ovary glabrous style bifid, very short, downwardly corved, glabrous. Seeds 0.3 cm long, oblong with 3 long smooth hairs at the base. (Fig. 1 A, B and C).

Distribution: In wet areas. Not common. Dudhatoli-Binsar area (Daira vill.) 2300 m, Sept. 1985. GUH. 6503.

Flowering-Fruiting: August-September.
Specimen examined: Himachal Pradesh, BSD, Uniyal 46283. 1971.

Euphorbia peples Linn. Hook. FBI. 5: 266; 1888. Erect annual herb, stem simple, 15-30 cm long, glabrous, rounded faintly ribbed, corymbosely branched in the upper part. Leaves opposite, cordate-ovate, upper sessile, lower shortly stalked, petiole 0.4-0.5 cm, leaves

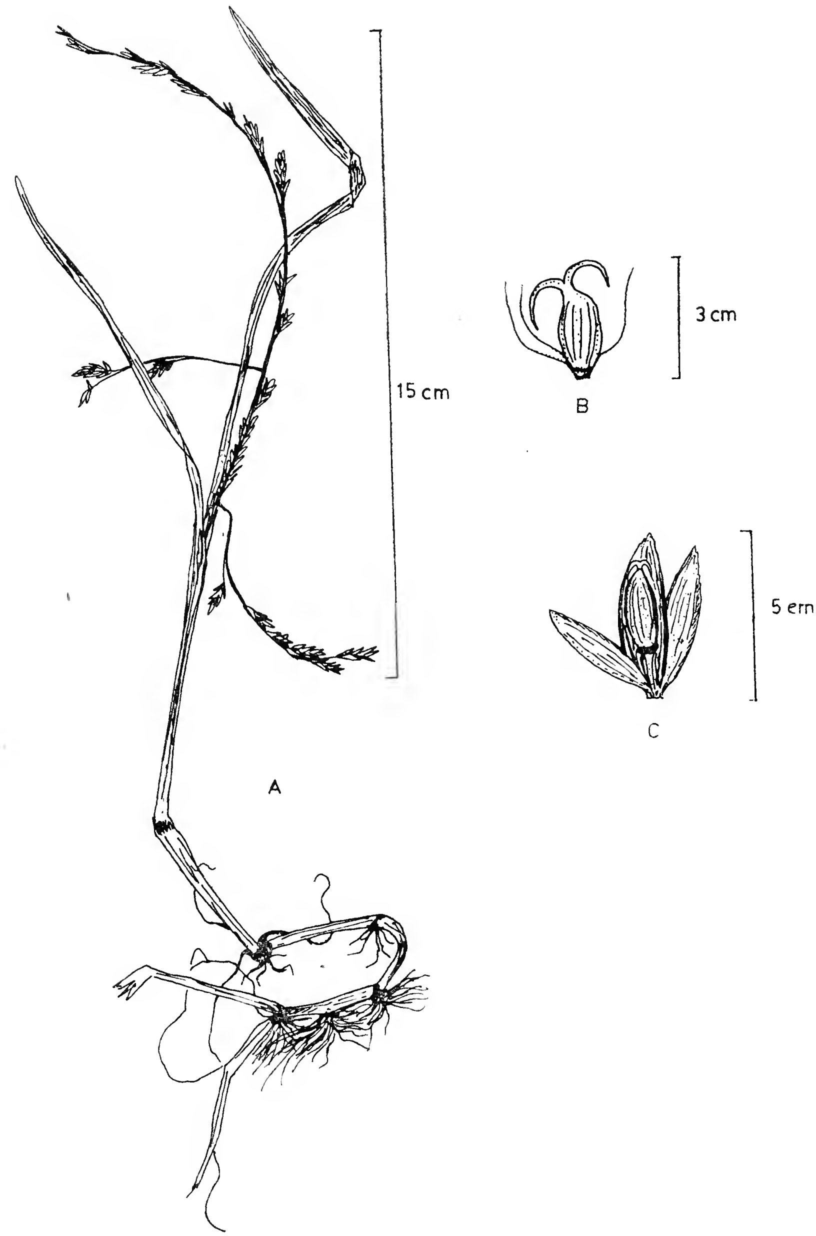

Fig. 1. *Glyceria tonglensis* Clarke
A. Plant with fertile spikelets; B. Single grain with bifid style; C. Fertile glumes.

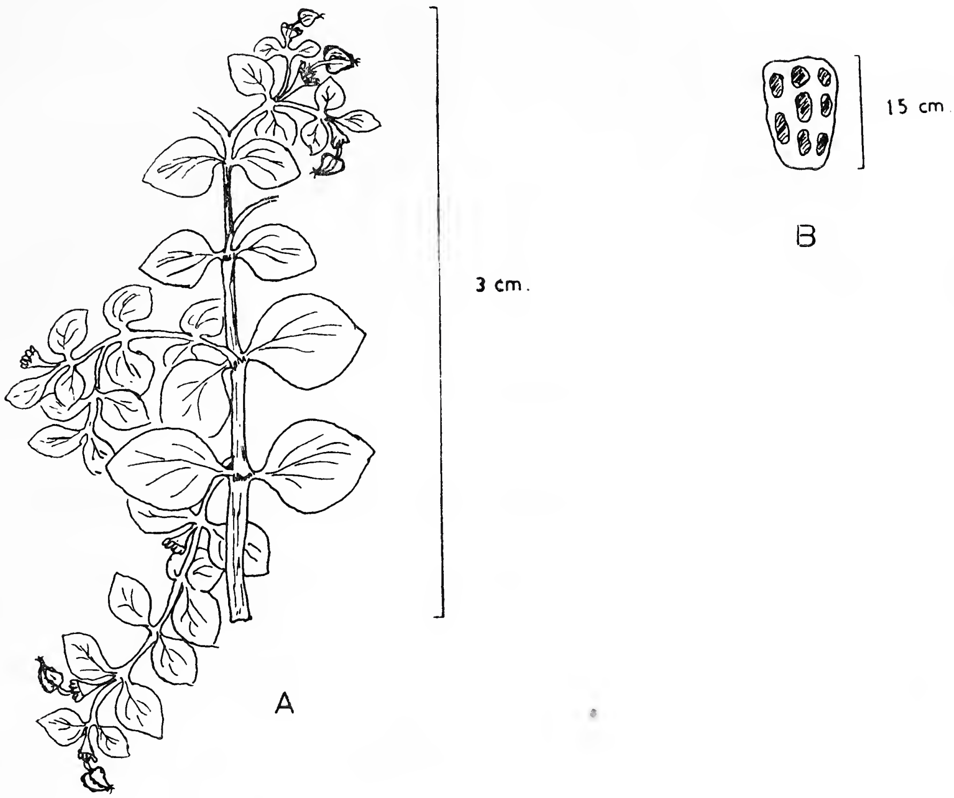

Fig. 2. *Euphorbia peples* Linn.
A. Flowering twig; B. Single pitted seed.

0.5-1.7 cm by 0.5-0.8 cm, thin, glabrous, margins entire. Flowers in dichotomous cymes, axillary and terminal. Involucre bracts 2 leaf like, 0.3-0.5 cm long. Teeth 4, surrounding the glands with projecting horns. Style short, Capsule smooth, slightly triangular, 0.2 cm long. Seeds 3, 0.15 cm long, longitudinally pitted in 5-6 rows. (Fig. 2 A and B).

Distribution: Common in open waste lands and Oak-Cedrus forest undergrowth, Chopra (Pauri) 1800-2000 m, April 1985. GUH. 6502.

Flowering-Fruiting: March-May.

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40. CORRECT NAME FOR *ANTIDESMA GHESAEMBILLA* GAERTN.

Recently we have been engaged in solving the nomenclatural problems involved in the identification of Rheede's figure in Hortus Malabaricus namely — "Tsjeriam-Cottam" (Vol. 5, page 21, plate 11). Our experience in the field and study of herbarium materials at Blatter Herbarium (BLAT) has led us to conclude that Rheede's figure is of the plant correctly known in our Indian floras under the name of *Antidesma ghesaembilla* Gaertn. However, one of the earlier names and its new combination — *Ardisia tsjeriam-cottam* R. & S. and *Embelia tsjeriam-cottam* (R. & S.) A. DC. which are based on Rheede's figures are mis-applied to a Myrsinaceous species. The nomenclature of the Myrsinaceous plant was tried by us earlier and is discussed further by G. Panigrahi and S. M. Almeida in a separate communication. In this paper we wish to point out some facts which we have discovered regarding the nomenclature of *Antidesma ghesaembilla* Gaertn.

While trying to understand the generic concepts of the genera *Embelia* Burm. f. and *Antidesma* Linn. it was found that in recent International Code of Botanical Nomenclature the generic name *Embelia* Burm. f. is conserved against *Ghesaembilla* Adans. as well as *Pattara* Adans. In the latest code (1983, ed. by Voss *et al.*) on page 393 in Index Nomina Genericum No. 6310 — *Embelia* N. L. Burm. Fl. Ind. 62, 1763 (type: *E. ribes* N. L. Burm.) is equated as (=) *Ghesaembilla* Adanson, Fam. Pl. 2: 499, 1763 as well as (=) *Pattara* Adanson, Fam. Pl. 2: 447, 588, 1763. (Type of this genus as per new edition, is mentioned as Rheede's Hort. Mal. 5: t. 11- *Tsjeriam-cottam*).

On further scrutiny of original literature it is found that *Ghesaembilla* Adanson is based on *Antidesma ghesaembilla* Gaertn.

To make sure about the conspecificity of *Antidesma ghesaembilla* Gaertn., with the monotypic genus *Embelia* Burm. f. we examined the original protologues of *Embelia* Burm. f. and *Antidesma ghesaembilla* Gaertn. and discovered that most part of the protologue is identical for both of them.

Therefore, under Article 63 of ICBN *Antidesma ghesaembilla* Gaertn. becomes an illegitimate name and must be rejected. The earliest legitimate name for the taxon under study is *Antidesma pubescens* Roxb. Pl. Corom.

2: 35, t. 167, 1802; Fl. Ind. 3: 770, 1832 and it should be accepted. Initially, Roxburgh had based his *A. pubescens* on his own material; but later in "Flora Indica" he has equated his material with the above mentioned Rheede's figure.

We thank Dr. D. H. Nicolson, Smithsonian Institution, for his useful comments, though — not always in agreement with our conclusions, and sending us all the necessary literature. We also thank the Herbarium Curator, Royal Botanical Garden, Kew; Dr. B. V. Shetty, Laison Officer, Kew; Mr. H. B. Naithani, Forest Research Institute, Dehra Dun and Dr. (Mrs.) A. R. Daruwalla for help rendered in preparing this article.

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41. NEW RECORDS OF FRESHWATER ALGAE FROM KARNATAKA STATE (INDIA)

(*With two plates*)

INTRODUCTION

Exploratory studies on freshwater algae in Karnataka State are mainly from North Kanara (Bharati 1965, 1966), Raichur (Bharati and Bongale 1975), Hassan (Bharati and Hegde 1980), Davanagere (Bongale and Bharati 1980), Shimoga (Bharati and Hegde 1982), Bijapur (Hegde and Bharati 1983), Mysore (Gurudeva *et al.* 1983) and Dharwad (Hosmani and Bharati 1983) districts. Extensive collections were made from freshwater ponds and lakes in Shimoga District during the years 1978-1980. These samples included 24 algal taxa which are new records to the algal flora of Karnataka State. They also contained two taxa with major variations. A detailed systematic account of these taxa is given in the

present paper. Classification given by Prescott, 1951 is followed for Blue-green and Euglenoid members. Desmids are arranged after Sarma and Khan, 1980. The samples are preserved in 4% formaldehyde solution and are deposited in the Algal Laboratory, P. G. Department of Botany, Karnatak University, Dharwad under the Accession No.'s S. 46; V. 61 to S. 91; V. 157.

Systematic Account

(The abbreviations used in the text are: L = Length; W = Width; I = Isthmus; T. = Thickness and D = Diameter).

Division : Cyanophyta
Class : Myxophyceae
Order : Chroococcales
Family : Chroococcaceae
Genus : *Glaucocystis* Itzigsohn 1866.

G. oocystiformis Prescott (Pl. 1; Fig. 11)
Prescott, 1951; pl. 108, fig. 3, p. 475.
L. 22-40 μm; W 16-24 μm.
Col. No. S. 78; V. 132.

Order : Hormogoniales
Sub-order : Heterocystineae
Family : Nostocaceae
Genus : *Anabaena* Bory 1922.

A. papillosa Hirano (Pl. 1; Fig. 1)
Hirano 1969; pl. 1, figs. 6&7, p. 12.
D cell 5 μm; D heterocyst 7 μm; L akinete 25 μm; W akinete 12 μm.
Col. No. S. 69; V. 107.

Agrees with the type in shape and structure of vegetative cells, heterocyst and akinete; differs in having much smaller size (Type D cell 7.5-8.8 μm; D heterocyst 10.5-11 μm; L akinete 35-55 μm; W akinete 15-16 μm).

Division : Chlorophyta
Class : Chlorophyceae
Order : Ulotrichales
Sub-order : Ulotrichinineae
Family : Ulotrichaceae
Genus : *Ulothrix* Kuetzing 1833.

U. tenerrima Kütz. (Pl. 1; Fig. 2)
Prescott 1951; pl. 6, fig. 12, p. 96.
L cell 10 μm; W cell 9 μm.
Col. No. S. 62; V. 92.

Order : Oedogoniales
Family : Oedogoniaceae
Genus : *Oedogonium* Link 1820.

O. cardiacum (Hass.) Wittrock (Pl. 1; Fig. 9)
Prescott 1951; pl. 29, figs. 7&8, p. 168.
L cell 70 μm; W well 16 μm; D zygospore 30 μm; D oogonium 45 μm.
Col. No. S. 61; V. 90.

O. santurcense Tiff. (Pl. 1; Fig. 10)
Gonzalves 1981; fig. 9-215; p. 333.
D zygospore without spines 25 μm; with spines 28 μm; D oogonium 32 μm.
Col. No. S. 83; V. 145.

Family : Oocystaceae
Genus : *Oocystis* Naegeli 1855.

O. pusilla Hansgirg (Pl. 1; Fig. 8)
Prescott 1951; pl. 51, fig. 15, p. 246.
L cell 35 μm; W cell 11 μm; L colony 53 μm, W colony 34 μm.
Col. No. S. 46; V. 61.

Differs in being almost double the size of the type (Type L cell 6-12 μm; W cell 3.8-7.5 μm).

Genus : *Schroederia* Lemmermann 1898.

S. indica Philipose (Pl. 1; Fig. 7).
Philipose 1967; fig. 19, p. 90.
L without spines 22 μm; With spines 46-50 μm, W 4 μm; L spine 12 μm.
Col. No. S. 91; V. 157.

Differs in being smaller in dimension (Type L without spines 28-44 μm; with spines 68-64 μm); inner side is almost straight instead of being concave as in the type.

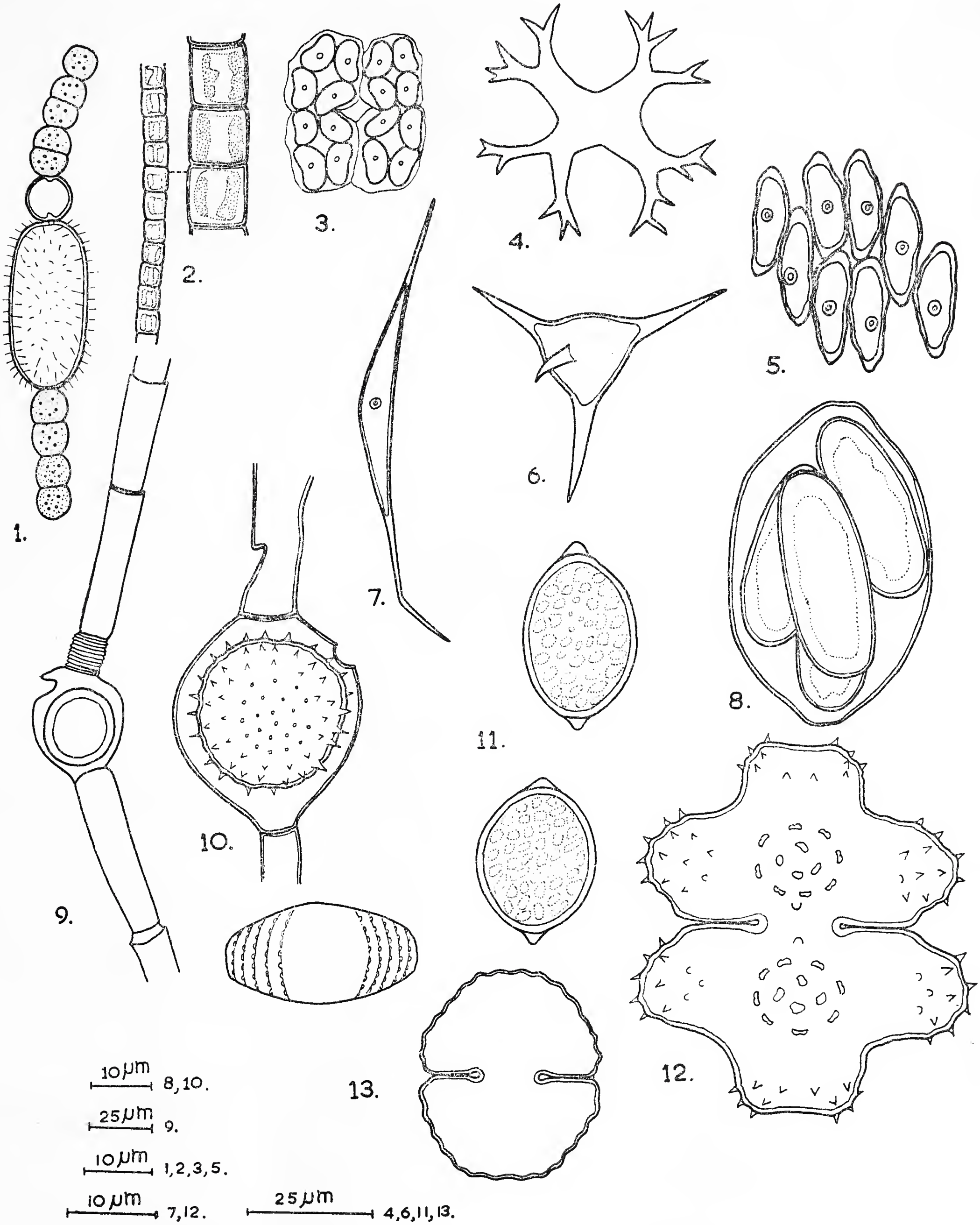

Fig. 1. *Anabaena papillosa* Hirano; Fig. 2. *Ulothrix tenerrima* Kütz; Fig. 3. *Crucigenia crucifera* (Wille) Collins; Fig. 4. *Tetraedron gracile* (Reinsch) Hansgirg; Fig. 5. *Scenedesmus arcuatus* Lemm. var. *capitatus* G. M. Smith; Fig. 6. *Tetraedron regulare* Kütz. var. *incus* Teil.; Fig. 7. *Schroederia indica* Philipose; Fig. 8. *Oocystis pusilla* Hansgirg; Fig. 9. *Oedogonium cardiacum* (Hass.) Wittrock; Fig. 10. *O. santurcense* Tiff.; Fig. 11. *Glaucocystis oocystiformis* Prescott; Fig. 12. *Euastrum ceylanicum* (W. *et* G.S. West) Krieg.; Fig. 13. *Cosmarium obtusatum* Schm. var. *undulatum* Fritsch *et* Rich.

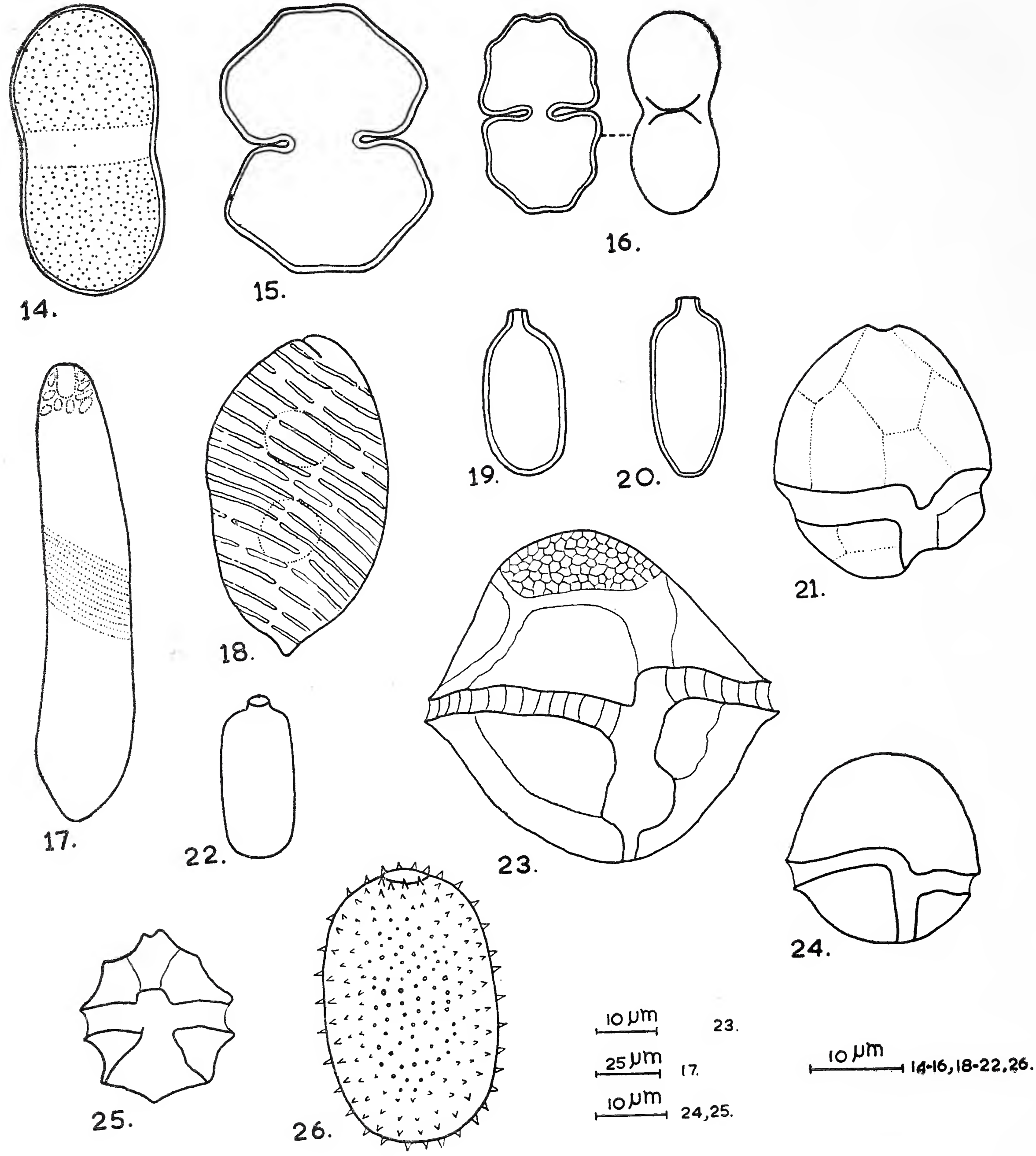

Fig. 14. *Cosmarium diplosporum* (Lund.) Lütkem.; Fig. 15. *C. pseudoretusum* Ducel. var. *africanum* (Fritsch) Krieg.; Fig. 16. *C. venustum* (Bréb.) Arch. var. *minus* (Wille) Krieg. et Gerl.; 17. *Euglena shrinagari* (Bhatia) Huber-Pest; Fig. 18. *E. oblonga* Schm.; Fig. 19. *Trachelomonas dubia* (Swir.) Deflandre; Fig. 20, *T. hexangulata* Swir.; Fig. 21. *Glenodinium penardiforme* (Lind.) Schiller; Fig. 22. *Trachelomonas cylindrica* Ehr.; Fig. 23. *Peridinium gatunense* Nygaard; Fig. 24. *Glenodinium pulvisculus* (Ehr.) Stein; Fig. 25. *Peridinium inconspicuum* Lemm.; Fig. 26. *Trachelomonas superba* (Swir.) Deflandre var. *duplex* Deflandre.

Genus : *Tetraedron* Kuetzing 1845.

T. gracile (Reinsch) Hansgirg (Pl. 1; Fig. 4).
Philipose 1967; fig. 69b, p. 154.
D without arms 14 μm; D with arms 48 μm.
Col. No. S. 91; V. 157.

Differs in having a spiny outgrowth on the inner side of each branch of second order instead of a forked branch of third order.

P. regulare Kütz. var. **incus** Teil. (Pl. 1, Fig. 6).
Prescott 1951; pl. 61, fig. 13, p. 269.
L spine 20 μm; D cell 20 μm.
Col. No. S. 79; V. 133.

Family : SCENEDESMACEAE
Genus : *Scenedesmus* Meyen 1929

S. arcuatus Lemm. var. **capitatus** G. M. Smith (Pl. 1, Fig. 5).
Prescott 1951; pl. 62, fig. 3, p. 275.
L cell 17 μm; W cell 6 μm.
Col. No. S. 62; V. 92.

Differs from the type in having irregular shaped cells. Wall is more thickened at the poles of cells. In this respect it resembles variety *capitatus* G. M. Smith described by Therezein and Coute 1977; pl. 6, fig. 1, p. 45.

Genus : *Crucigenia* Morren 1830.

C. crucifera (Wille) Collins (Pl. 1; Fig. 3).
Philipose 1967; fig. 149, p. 240.
L cell 7 μm; W cell 4 μm.
Col. No. S. 74; V. 120.

Class : Conjugatophyceae
Order : Conjugales
Family : DESMIDIACEAE
Genus : *Euastrum* Ehrenberg 1832.

E. ceylanicum (W. et G. S. West) Krieg. (Pl. 1; Fig. 12).
Scott and Prescott 1961; pl. 11, figs. 3-5, p. 24.
L 40 μm; W 80 μm; I 6 μm.
Col. No. S. 87; V. 149.

Genus : *Cosmarium* Corda 1834.

C. diplosporum (Lund.) Lütkem. (Pl. 2; Fig. 14).
Hirano 1967; pl. 9, fig. 5, p. 47.
L 58 μm; W 28 μm; I 20 μm.
Col. No. S. 88; V. 151.

C. obtusatum Schm. var. **undulatum** Fritsch *et* Rich (Pl. 1; Fig. 13).
Grönblad and Croasdale 1971; pl. 6, fig. 80, p. 16.
L 44 μm; W 38 μm; I 10 μm; T 20 μm.
Col. No. S. 78; V. 132.

C. pseudoretusum Ducel. var. **africanum** (Fritsch) Krieg. *et* Gerl. (Pl. 2; Fig. 15).
Grönblad and Croasdale 1971; figs. 69-71; p. 17.
L 28 μm; W 21 μm; I 6 μm.
Col. No. S. 82; V. 141.

C. venustum (Bréb.) Arch. var. **minus** (Wille) Krieg. *et* Gerl. (Pl. 2; Fig. 16).
Grönblad and Croasdale 1971; pl. 6, fig. 82, p. 19.
L 21 μm; W 12 μm; I 3 μm; T 8-9 μm.
Col. No. S. 91; V. 157.

Division : Euglenophyta
Class : Euglenophyceae
Order : Euglenales
Family : EUGLENACEAE
Genus : *Euglena* Ehrenberg 1838.

E. oblonga Schm. (Pl. 2, Fig. 18)
Philipose 1982; fig. 21, p. 591.
L 66 μm; W 40 μm.
Col. No. S. 87; V. 149.

E. shrinagari (Bhatia) Huber-Pest. (Pl. 2; Fig. 17).
Philipose 1982; figs. 13 a-d, p. 577.
L 183 μm; W 50 μm.
Col. No. S. 55; V. 72.

Genus : *Trachelomonas* Ehrenberg 1835.

T. cylindrica Ehr. (Pl. 2; Fig. 22)
Prescott 1951; pl. 83, fig. 11 and 20, p. 412.
L 17 μm; W 7 μm.
Col. No. S. 91; V. 157.

T. dubia (Swir.) Deflandre (Pl. 2; Fig. 19).
Prescott 1951; pl. 85, fig. 9, p. 412.
L 24 μm; W 12 μm.

Col. No. S. 81; V. 137.

T. hexangulata Swir. (Pl. 2; Fig. 20).
Prescott 1951; pl. 85, fig. 11, p. 418.
L 17 μm; W 8 μm.
Col. No. S. 67; V. 103.

Varies in being half the size of the type (Type test L 30-36 μm; W 14-16 μm).

T. superba (Swir.) Deflandre var. **duplex** Deflandre (Pl. 2; Fig. 26).
Prescott 1951; pl. 84, fig. 11, p. 417.
L 30 μm; W 18 μm; W with spines 22 μm.
Col. No. S. 91; V. 157.

Similar to the type in size, differs in shape and ornamentation. Unlike the variety described the test is elongate-ellipsoid, broadly rounded at both ends, spines are of uniform size.

Division : Pyrrhophyta
Class : Dinophyceae
Order : Peridiniales
Family : GLENODINIACEAE
Genus : *Glenodinium* (Ehr.) Stein 1883.

G. penardiforme (Linde) Schiller — (Pl. 2; Fig. 21)
Prescott 1951; pl. 90, fig. 21, p. 429.
L 25 μm; W 21 μm.
Col. No. S. 55; V. 72.

G. pulvisculus (Ehr.) Stein — (Pl. 2; Fig. 24)
Prescott 1951; pl. 90, figs. 17 & 18, p. 430.
L 26 μm; W 28 μm.
Col. No. S. 67; V. 103.

Family : PERIDINIACEAE
Genus : *Peridinium* Ehrenberg 1832.

P. gatunense Nygaard — (Pl. 2; Fig. 23).
Prescott 1951; pl. 90, fig. 26, p. 433.
L 53 μm; W 57 μm.
Col. No. S. 55; V. 71.

P. inconspicuum Lemm. — (Pl. 2; Fig. 25).
Prescott 1951; pl. 90, figs. 22-24; p. 433.
L 25 μm; W 22 μm.
Col. No. S. 61; V. 90.

SUMMARY

Freshwater algal collections were made in Shimoga District, Karnataka State, during the year 1978-80. A systematic account of 24 algal taxa, recorded for the first time from this State and two taxa with major variations is given. These taxa belong to the groups, Cyanophyceae (2), Chlorophyceae (14), Euglenophyceae (6) and Dinophyceae (4).

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42. LIMNOLOGY OF THE THERMAL SPRINGS OF ORISSA

(*With two text-figures*)

The physico-chemical characteristics and floristic life of the two thermal springs of Orissa state — Taptapani in Ganjam dist. and Autri in Puri dist. had been investigated for one year. The temperature of the thermal springs remained almost constant during the period of investigation. The water of both the springs were alkaline with a pH between 9.2 to 9.6. No carbon dioxide and only traces of nitrate, nitrite and phosphate was detected. A number of blue-green algae and diatoms and few zooplanktons were recorded in these hot water springs. The quantity of plankton was maximal in the main tank of Taptapani and only in the overflows of Autri. None of the organisms except the blue-green algae *Mastigocladus laminosus* (Cohn) and *Oscillatoria teribriformis* (Ag.) and the diatoms: *Navicula* sp. and *Cyclotella* sp. were found in the main tank of Autri at 55°C.

INTRODUCTION

Extensive reports are available on the limnology of several thermal springs of U.S.A., Europe, Japan, Israel and New Zealand (Castenholz 1967, 1968, 1969, 1970; Brock & Brock 1966, 1967, 1968, 1969; Peary 1964, Stockner 1967, 1968; Emoto 1967, Kahan 1969). Most of the investigations aimed at elucidating the upper temperature limit of life and to report on the organisms that occur in the hot springs. Though India has over three hundred hot water springs (Oldham & Oldham 1882), our knowledge on the organisms inhabiting high temperature habitats is very meagre. Kirtikar (1886) was the first to record a thermal alga from India.

Drouet (1938) described a few thermal alga during the Yale North Indian Expedition. Prasad & Srivastava (1965) and Thomas & Gonzalves (1965) have given an account of blue-green algae vegetation on the thermal springs of Himachal Pradesh, Gujarat and Maharashtra. Vasistha (1968) studied extensively the algal flora and the chemical constituents of about a hundred thermal stations distributed all over India. But the psysico-chemical nature of the thermal water and the organisms inhabiting the two thermal springs of Orissa have not been investigat-so far. The present investigation was aimed at determining the physico-chemical characteristics of the thermal water and the flora and fauna of the hot water springs of Taptapani (in Ganjam dist.) and Autri (in Puri dist.) of Orissa state, India.

Location and Description of the study sites

1. *Taptapani*:

This hot spring is situated at a distance of 56 kilometres (south wards) from Berhampur (19° 16′ N, 84° 53′ E) near a small village called Taptapani. It has a main tank, octangular in shape (constructed with bricks and cement by the local people) from where the mineral water and gases in the form of bubbles continuously escape (Fig. 1). Each arm of the tank is 104″ in length and are 120″ apart from one another. It has a outlet through which the water over flows. In the main tank the water level varies at different spots and its sandy bottom is full of rocks. The overflows are cemented at the bottom and are used for bathing purpose. The length, breadth and water height of 1st and 2nd over flows are 232″ × 104″ × 26″ and 105″ × 104″ × 23″ respectively. From the 2nd over flow water flows to the out side. It is believed that the water has therapeutic properties.

2. *Autri*:

This thermal spring is situated at a distance of 43 kilometres (west wards) from Bhubaneswar (20° 12′ N, 85° 22′ E) near a small village called Baghamari. It has a circular main tank of 161″ diameter and 168″ depth (artificially constructed) from where water and gases escape from the bottom in the form of bubbles (Fig. 2). Similar to Taptapani it has a rocky bottom but the water depth is very deep (139″). Just above the water level there are two separate outlets through which water flows to the two separate cemented bathing tanks (overflows). The 1st and 2nd overflows are placed at 77″ and 334″ distance from the main tank with an area of 135″ × 135″ and 120″ × 120″ respectively. Both the overflow tanks have around 40″ of water height throughout the year and from these tanks water flows to the surrounding rice-fields.

Methods

Water samples with different algal mats were collected from the main tank and the overflows of Taptapani and Autri between July 1981 and May 1982 at regular intervals. Temperature was recorded on the spot with a mercury thermometer graduated upto 100°C. The hydrogen-ion-concentrations of the thermal water was determined by using a digital pH meter. Water samples collected during February 1982 from both the thermal springs were analysed for the presence of various chemicals according to the standard methods for the examination of water and waste water (1965) and were indicated in parts per million. Plankton samples were collected by filtering known quantity of the water taken from different spots of the main tank and the

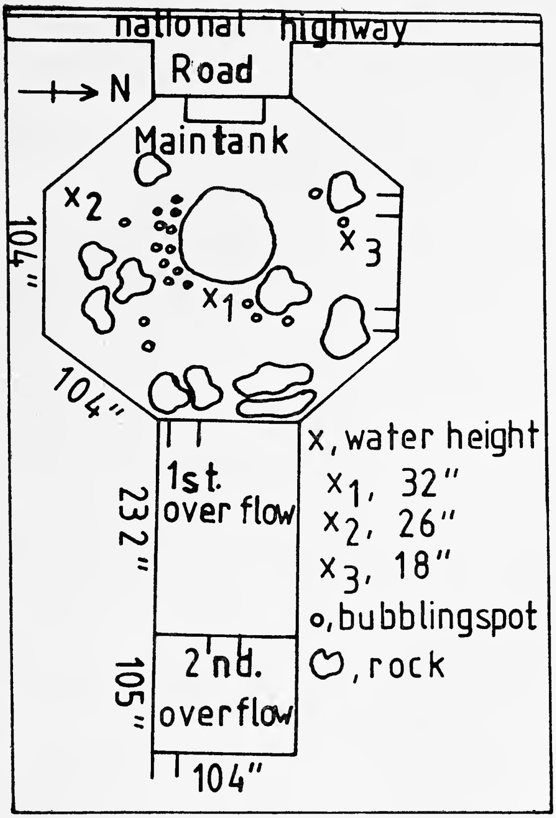

Fig. 1. Diagramatic representation of the study site of the hot water spring at Taptapani.

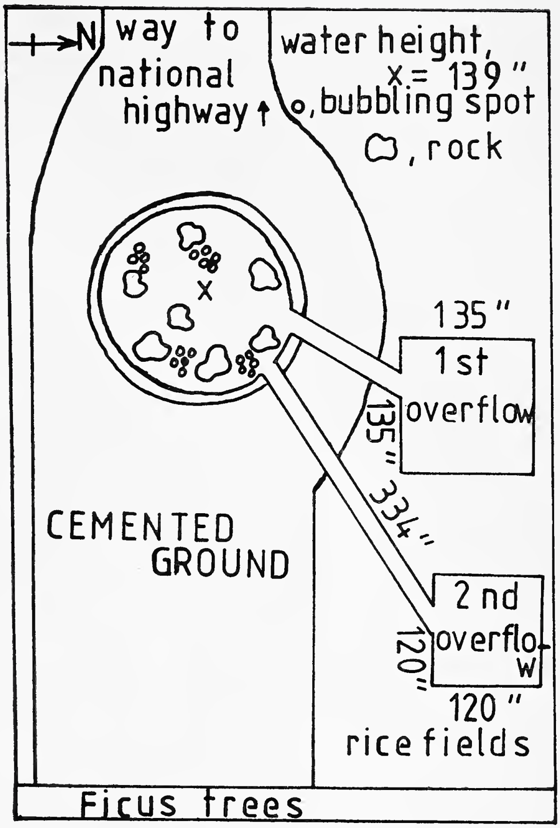

Fig. 2. Diagramatic representation of the study site of the hot water spring at Autri.

over flows of the thermal springs through a plankton net made of standard bolting silk cloth (No. 21 with 77 meshes/sq. cm.). The concentrated plankton was preserved in four percent formalin and quantitatively determined by the sedimentation and drop count method. The various phytoplanktons were identified according to Desikachary (1954) and Fritsch (1939).

Results and discussion

The physico-chemical characteristics of the thermal water of the springs of Taptapani and Autri are presented in Table 1 and Table 2. The investigation was carried out to see whether the temperature and pH of both the springs differ from one another and also to find out whether there was any periodic fluctuation of the temperature and pH of an individual spring. From the results (Table 1) the periodic fluctuation of the temperature of both the springs was insignificant and the minor variation may be due to the change of climatic temperature of the regions during different seasons. The local inhabitants state that the temperature of these ther-

TABLE 1

PHYSICAL CONDITION OF THE WATER OF TAPTAPANI AND AUTRI OF ORISSA[1]

Date of investigation	Taptapani Temperature°C			pH	Autri Temperature°C			pH
	Main tank	1st over flow	2nd over flow		Main tank	1st over flow	2nd over flow	
July 1981	44.5	43.5-44.5	40.0-42.0	9.1	56.5	46.5-48.0	46.0-48.0	9.6
Sept. 1981	44.0	43.0-44.0	40.0-41.0	9.2	55.5	45.0-48.0	45.0-48.0	9.7
Nov. 1981	44.0	42.0-43.5	40.0-41.0	9.2	55.0	45.0-48.0	45.0-47.0	9.7
Jan. 1982	44.0	42.0-44.0	40.0-41.0	9.2	55.0	46.0-48.0	46.0-48.0	9.7
March 1982	44.0	43.0-44.0	40.0-41.0	9.2	55.5	46.0-49.0	46.0-49.0	9.8

[1] The water of both the hot springs were clear and produced the characteristic smell of sulphur.

mal springs has remained constant over the past few decades and the location of the fissures have also remained unchanged. There were also reports that many hot springs were constant in their thermal and hydrologic properties over a few hundred years (Brock & Brock 1967, Stockner 1968, Castenholz 1969). The slightly low pH of the water during July may be due to the inflow of rain water from the surrounding area. It has been analysed that the water of both the hot springs were free of CO_2. There were reports (Brock & Brock 1966) that light and CO_2 were not the limiting factors for phytoplankton production in alkaline hot springs. The water sample of both the thermal springs investigated had traces of nitrate, nitrite and phosphorus (Table 2). However, chloride, carbonate and silicate were present at various proportions which normally is not found in fresh water pools. In addition sulphurated hydrogen was present in the spring water, which emit H_2S gas smell. Total solids and dissolved oxygen of the water of Taptapani was more in comparison to the thermal water of Autri (Table 2). These physico-chemical characteristics of the hot water springs were mainly responsible for the growth of various organisms in the spring water.

TABLE 2

CHEMICAL CHARACTERISTIC OF THE WATER FROM TAPTAPANI AND AUTRI OF ORISSA

Constituents	Water from the main tank of Taptapani (1)	Water from the main tank of Autri (2)
Free CO_2	Nil	Nil
Total solids (ppm)	580	240
Total hardness ($CaCO_3$) (ppm)	9.8	14.0
Chloride (Cl^-) (ppm)	92.0	130.0
Nitrate (NO_3^-) (ppm)	trace	trace
Nitrite (NO_2^-) (ppm)	trace	trace
Phosphate (PO_4^-) (ppm)	trace	trace
Silicate (SiO_3^-) (ppm)	48.0	33.6
Dissolved O_2 (ppm)	4.9	1.4
Sulphurated hydrogen (as H_2S)	Present	Present

(1) = Collected on 10.2.1982.

(2) = Collected on 12.2.1982.

TABLE 3

DISTRIBUTION OF PLANKTON IN THE MAIN TANK AND OVER FLOWS OF TAPTAPANI AND AUTRI OF ORISSA

	Taptapani			Autri		
	Main tank	1st over flow	2nd over flow	Main tank	1st over flow	2nd over flow
Total plankton/ 1000 ml	438,080	322,650	150,470	650	290,200	248,560
Total zooplankton/ 1000 ml	14,150	10,820	4,400	Nil	18,600	22,350
Zooplankton percentage	3.23	3.35	2.92		6.4	8.99
Total phytoplankton/ 1000 ml	423,930	311,830	146,070	650	271,600	226,210
Phytoplankton percentage	96.76	96.64	97.07	100	93.59	91.0

TABLE 4

OCCURRENCE OF VARIOUS ORGANISMS IN THE MAIN TANK AND THE OVER FLOWS OF TAPTAPANI AND AUTRI OF ORISSA

Organism	Taptapani			Autri		
	Main tank	1st over flow	2nd over flow	Main tank	1st over flow	2nd over flow
Synechococcus lividus (Copeland)	++	++	++	–	–	–
Synechococcus elongatus (Näg)	++	++	++	–	–	–
Synechosystis aquatilis (Sanv.)	+	+	+	–	–	–
Aphanothece sp.	+	+	+	–	–	–
Chroococcus minor (Nätz) Näg	++	++	++	–	++	++
Oscillatoria teribriformis (Ag.)	++(+)	++	++	++(+)	++(+)	++(+)
Oscillatoria princeps (Vauch.)	–	–	–	–	+	+
Oscillatoria tenuis (Ag.)	–	–	–	–	+	+
Phormidium purpurascens (Kütz) Gom.	+	+	+	–	+	+
Phormidium sp.	–	–	–	–	+	+
Lyngbya sp.	+	+	+	–	+	+
Spirulina sp.	++	++	++	–	++	++
Anabaena sp.	+	+	+	–	+	+
Mastigocladus laminosus (Cohn)	++(+)	++	++	++(+)	++(+)	++(+)
Cosmarium sp.	+	+	+	–	+	+
Scenedesmus sp.	–	–	–	–	+	+
Cyclotella sp.	++(+)	++	++	++(+)	++(+)	++(+)
Navicula sp.	++(+)	++	++	++(+)	++(+)	++(+)
Euglena sp.	+	+	+	–	+	+
Tobrilus sp.	+	+	+	–	–	–
Cyclops sp.	+	+	+	–	+	+
Lacane sp.	–	–	–	–	+	+
Nauplius larva	+	+	+	–	–	–

+ = Present; – = absent; ++ = Occur abundantly; (+) = Occur throughout the year.

The thermal water of Taptapani encouraged the growth of a number of organisms mostly phytoplanktons which imparts deep green coloration to the spring. Quantitatively, highest plankton population was observed in the main tank of Taptapani. In its overflows the plankton population was a little less and in the 2nd over flow the number of planktons was reduced. Since both the overflows are normally used for bathing, the mats were partially cleared by the tourists. The high temperature of the clear water of Autri do not encourage the growth of a large number of plankton. The over flows, where the temperature of the water was less there was luxurious growth of various organisms. Zooplanktons were totally absent in the main tank of Autri. This may be due to the higher temperature of the spring. However, abundance of phytoplankton and zooplankton were noticed in both of its over flows. Due to higher water depth of the over flows of Autri, the tourists normally do not enter the tanks for bathing, thus do not disturb the growth of the plankton mats. The plankton mats collected from various spots of the main tank and over flows of both the thermal springs composed of mostly members of cyanophyceae, diatoms and a few zooplankton (Table 3). Similar gelatinous and calcareous mats of various colours consisting of blue-green algal cells have also been reported in other hot springs of Europe and America (Castenholz 1969, Stockner 1967). From these results it seems that the temperature may be the major factor in determining the qualitative and quantitative distribution of planktonic organisms. The differences in the floristic pattern and the productivity of the hot springs may be due to the difference in concentration of the mineral elements of the spring water.

Of the various thermophilic organisms, only *Chroococcus minor* (Nätz) Näg., *Oscillatoria teribriformis* (Ag.), *Spirulina* sp., *Mastigocladus laminosus* (Cohn), *Cyclotella* sp. and *Navicula* sp. occur in both the hot water springs and in addition *Synechococcus lividus* (Copeland) and *Synechococcus elongatus* (Näg.) occur abundantly in Taptapani. In addition a number of blue-green algal forms, green algae, *Euglena* and various zooplanktons were also observed in the thermal water (Table 4). Certain thermophilic organisms, viz. *Oscillatoria teribriformis* (Ag.), *Mastigocladus laminosus* (Cohn), *Cyclotella* sp. and *Navicula* sp. occur abundently in the thermal water even at 55°C in the hot water spring of Autri throughout the year of investigation. There are records that a large number of *Spirulina* sp., *Chroococcus* sp., *Aphanothece* sp. *Anabaena* sp., *Oscillatoria* sp., *Navicula* sp. and *Cyclotella* sp. have been collected from thermal springs with 26-50°C temperature range (Gonzalves 1947, Prasad & Srivastava 1965, Vasistha 1968). There were also reports that *Oscillatoria* sp. has the ability to grow at high temperature in various thermal springs of India (Gonzalves 1947, Prasad & Srivastava 1965). The occurrence of a common thermophilic blue-green alga *Mastigocladus laminosus* (Cohn) (Castenholz 1970) at temperatures upto 55°C in the thermal water of Taptapani and Autri of Orissa is a new record from Indian thermal springs.

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Fig. 1. Diagramatic representation of the study site of the hot water spring at Taptapani.

Fig. 2. Diagramatic representation of the study site of the hot water spring at Autri.

ERRATA

VOLUME 83 (Supplement): CENTENARY ISSUE 1886-1986

Phytochorology of Kodagu (Coorg) District, Karnataka.

On page 48, Left column,

Among other important families are the:

For	*Read*
Anacardiaceae (*Holigarna, Mangifera, Meliosma*),	Anacardiaceae (*Holigarna, Mangifera*),
Celastraceae (3 species of *Elaeocarpus*),	Celastraceae (*Bhesa, Celastrus, Euonymus*),
Euphorbiaceae (*Agrostistachys, Glochidion, Mallotus* ...),	Elaeocarpaceae (3 species of *Elaeocarpus*),
Flacourtiaceae (*Casearia, Flacourtia, Hydnocarpus, Scolopia*),	Euphorbiaceae (*Agrostistachys, Glochidion, Mallotus* .....),
Myrsinaceae (*Ixora, Lasianthus, Psychotria*...),	Flacourtiaceae (*Casearia, Flacourtia, Hydnocarpus, Scolopia*),
Staphyleaceae (*Turpinia*),	Rubiaceae (*Ixora, Lasianthus, Psychotria*),
Symplocaceae (*Symplocos*).	Sabiaceae (*Meliosma*),
	Staphyleaceae (*Turpinia*),
	Symplocaceae (*Symplocos*).

MISCELLANEOUS NOTES

1. Painted bats and nests of Baya Weaver bird.
On page 196, Right Column, Line 5.

For Lizyphus spp. *Read Zizyphus* spp.

VOLUME 84 (1): APRIL 1987

MISCELLANEOUS NOTES

23. A list of the snakes of the Bhavnagar District, Gujarat State.

On page 230, Table 2

For

(5)	Barred Wolf Snake	–(4)	–(7)	1(16)	2(24)
(6)	Common Wolf Snake	10	15	5	6
(14)	Common bronzeback Tree Snake	2	5(2)	3(2)	5(2)
(15)	Common Cat Snake	6(1)	1	1(1)	3(1)
(16)	Common Krait	2	1	–(2)	1(2)

Read

(5)	Barred Wolf Snake	–	–	1	1
(6)	Common Wolf Snake	10(4)	15(7)	5(16)	6(24)
(14)	Common bronzeback Tree Snake	2	1	–(2)	1(2)
(15)	Common Cat Snake	6(1)	5(2)	3(2)	5(2)
(16)	Common Krait	2	1	1(1)	3(1)

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CETACEANS (WHALES, DOLPHINS AND PORPOISES) RECORDED OFF SRI LANKA, INDIA, FROM THE ARABIAN SEA AND GULF, GULF OF ADEN AND FROM THE RED SEA[1]

P. H. D. H. de Silva[2]

(*With two plates and two text-figures*)

Introduction

Cetacea is a highly specialized oceanic group of mammals with several of its species undertaking long migrations, often exceeding thousand miles during a single journey. During these migrations from cold polar and subpolar seas to warmer tropical and subtropical waters and their return to polar seas in summer both individual and mass strandings have very often occurred in many parts of the world, including Sri Lanka, India and the Arabian Gulf.

The Cetacean records dealt with in this paper are of countries which lie at the extreme southern margin of the vast land mass of Asia with no land other than a few islands and vast stretches of the Indian Ocean between them and the Antarctica. Sri Lanka, in view of her geographic position at the southern extremity of this vast land mass (5° 55′ and 9° 51′ N latitude and 79° 41′ and 81° 54′ E longitude) has become a passing point in the movement of oceanic species including the larger whales. It has been suggested by Deraniyagala (1945, 1960b) that the movement of larger species towards the tropics from the southern temperate zone is partly associated with the periodic influx of Antarctic water toward the tropics. It is however, now fairly established that several larger species such as the Blue whale, the Fin whale and the Humpback whale show a regular migratory cycle.

The majority of strandings recorded in this paper deal with individual strandings. Nevertheless there have been instances of both mass stranding and of apparent suicidal behaviour.

This paper deals with 30 Cetacean species from the region. Of these records, records from

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Sri Lanka total 23 species, from India 24 species, from Pakistan 17 species, from the Gulf of Oman 10 species, from the Arabian Gulf 9 species, from the Gulf of Aden 6 species and from the Red Sea 7 species.

Reference is also made to a skull of *Delphinus tropicalis* van Bree in the Colombo Museum (Skull No. 15 B) which appears to be its first record from Sri Lanka. Mention is also made of a specimen of *Neophocaena phocaenoides* (G. Cuvier) collected from the Wadge Bank by the Smithsonian Carangid Survey Team in March 1970 and of two incomplete skeletons of *Balaenoptera physalus* (Linné) (probably mother and calf) in the Zoological Museum, King Saud University, Riyadh, Saudi Arabia. All these specimens were identified by me.

It is evident from this study that our present knowledge of the Cetacean fauna of the Indian Ocean is far from complete and that much could be accomplished by scientific institutions in the countries in the region by deligently maintaining proper records of sightings and strandings (with photographs) and by undertaking joint study surveys. It is gratifying to note that Sri Lanka, in recent years has been making much headway in this regard. During the last few years the Tulip Expedition led by Dr. Hal Whitehead has been studying the larger whales, especially the larger whales off the east coast and Dr. Stephen Leatherwood Of Hubbs-Sea World Research Institute (Marine Science), San Diego, California has recently published (1985) a summary of available information on the Cetacea of the Indian Ocean Cetacean Sanctuary on behalf of the National Aquatic Resources Agency for Sri Lanka. It is hoped that the present paper will further stimulate interest among the scientific institutions in the region and help to increase our knowledge of a group of remarkable animals at least as far as the species which inhabit and visit our seas.

A key to the identification of the species recorded from the region is given in Appendix.

Cetacean species recorded

The Cetacean species recorded from the region are given below:

I. Suborder ODONTOCETI — Toothed Whales
- i. Superfamily PLATANISTOIDEA — River Dolphins
  - a. Family PLATANISTIDAE
    - 1. *Platanista gangetica* (Roxburgh, 1801)
    - 2. *Platanista minor* Owen, 1853
- ii. Superfamily PHYSETEROIDEA — Sperm Whales
  - b. Family PHYSETERIDAE
    - 3. *Physeter macrocephalus* Linnaeus, 1758
    - 4. *Kogia simus* Owen, 1866
- iii. Superfamily ZIPHIOIDEA — Beaked Whales
  - c. Family ZIPHIIDAE
    - 5. *Ziphius cavirostris* G. Cuvier, 1823
    - 6. *Mesoplodon ginkgodens* Nishiwaki and Kamiya, 1958
- iv. Superfamily DELPHINOIDEA — Dolphins
  - d. Family STENIDAE
    - 7. *Steno bredanensis* (Lesson, 1828)
    - 8. *Sousa chinensis* (Osbeck, 1765)
  - e. Family DELPHINIDAE
    - 9. *Tursiops truncatus* (Montagu, 1821)
    - 10. *Delphinus delphis* Linnaeus, 1758
    - 11. *Delphinus capensis* Gray, 1828
    - 12. *Delphinus tropicalis* van Bree, 1972
    - 13. *Stenella attenuata* (Gray, 1846)
    - 14. *Stenella longirostris* (Gray, 1828)
    - 15. *Stenella coeruleoalba* (Meyen, 1833)
    - 16. *Grampus griseus* (G. Cuvier, 1812)
    - 17. *Peponocephala electra* (Gray, 1846)
    - 18. *Globicephala macrorhynchus* Gray, 1846
    - 19. *Feresa attenuata* Gray, 1874
    - 20. *Pseudorca crassidens* (Owen, 1846)
    - 21. *Orcinus orca* (Linnaeus, 1758)
    - 22. *Orcaella brevirostris* (Gray, 1866)
  - f. Family PHOCOENIDAE
    - 23. *Neophocaena phocaenoides* (G. Cuvier, 1829)

II. Suborder MYSTICETI — Baleen Whales
- g. Family BALAENIDAE
  - 24. *Eubalaena australis* Desmoulins, 1822
- h. Family BALAENOPTERIDAE
  - 25. *Balaenoptera musculus* (Linnaeus, 1758)
  - 26. *Balaenoptera physalus* (Linnaeus, 1758)
  - 27. *Balaenoptera acutorostrata* Lacépede, 1804
  - 28. *Balaenoptera borealis* Lesson, 1828
  - 29. *Balaenoptera edeni* Anderson, 1878
  - 30. *Megaptera novaeangliae* (Borowski, 1781)

SIGHTINGS, STRANDINGS AND OTHER RECORDS OF THE SPECIES

1. **Platanista gangetica** (Roxburgh, 1801)

GANGES SUSU, GANGES DOLPHIN

Records:

INDIA [Inhabits the Ganges, Brahmaputra and Meghna river systems ranging from the sea to the foot of the mountains. Though common in tidal waters it never enters the sea (Blanford 1891, 591].

2. **Platanista minor** Owen, 1853

INDUS SUSU, INDUS DOLPHIN

Records:

PAKISTAN [Inhabits the Indus river system in silt laden rivers. They do not enter the tidal waters of the Indus].

3. **Physeter macrocephalus** Linnaeus, 1758

SPERM WHALE, CACHALOT

Records:

SRI LANKA [Several *sightings* in Gulf of Mannar, December 1840's — Wray and Martin, 1980, off Sri Lanka from 13th February to 11th March 1982 and Gulf of Mannar, February and March 1982-Alling *et al.*, 1982; off north-eastern coast, April 1982 to 16th April 1983 — Leatherwood *et al.*, 1984; off coast of Dondra (S.P.) on 7th May 1985 — Gunaratne and Obeysekera, 1985; *strandings* from coast of Mannar (N.P.) in September 1889, Bentota (W.P.) in July 1904, Marawila (N.W.P.) on 11th March 1939, Kalpitiya (N.W.P.) in August 1946, Kathaluwa (S.P.) in 1946, Chilaw (N.W.P.) in August 1946, Ambalangoda on 30th August 1960 and Kahawa, Ambalangoda (S.P.) on 11th January 1966. Two specimens caught on 7th September 1982 from Pitipana, Negombo (W.P.) and another in drift net — Joseph *et al.* 1983 and De Bruin, 1972].

INDIA [*Sightings* — off Nicobar and Andaman Islands, March and April 1920 — Townsend, 1935, Madras in January 1890 observed by Thurston — Blanford, 1891, 571; South of India on 19th April 1983, 3 animals — Leatherwood *et al.*, 1984; *strandings* — Karwar on 23rd June 1972 — Antony Raja and Vasudev Pai, 1973, Manauli Island, a male in July 1979 — James, 1983; Mahabalipuram, near Madras on 12th April 1980 — James and Manivasagam, 1980; Krusadai Island on 30th April 1980, Pirthentburuth Island near Quilon on 25th November 1980 and Pudupet near Cuddalore on 8th June 1982 — James, 1983 and another from Pudupet, east coast — Kuthalingam *et al.*, 1982].

PAKISTAN [Sind and Baluchistan coasts — Ahmad and Ghalib, 1975].

GULF OF OMAN [*Sightings* on 16th and 18th January 1982 — Alling, 1982 and Masirah, Oman — Ross, 1981].

4. **Kogia simus** Owen, 1866

DWARF SPERM WHALE, SMALL SPERM WHALE

Records:

SRI LANKA [*Sightings* — Trincomalee (E.P.) in 1891 — Pearson, 1931; east coast on 11th

and 23rd April 1983 — Alling, 1983; *strandings* — right tympanum and periotic bones of a skull from Trincomalee (E.P.) gifted by Hugh Nevill to the British Museum (Natural History), No. 1891.10.3.1; Moratuwa (W.P.) on 3rd November 1915 — Pearson, 1921; Gunapana (S.P.) on 9th August 1936 and at Wadduwa (S.P.) on 14th August 1960 — Deraniyagala, 1960, 1961; Pitipana, Negombo (W.P.) caught 18th November 1982 — Joseph *et al.* and 18 animals caught off Trincomalee (E.P.) from 9th February 1983 to April 1985 — Prematunga *et al.*, in press and Beruwala (S.P.) — Alling, 1983].

INDIA [Vizagapatam — Blanford, 1891; skull from Madras of a female, No. 1866.2.5.6, on 28th February 1853, gifted by Sir Walter Elliot to the British Museum (Natural History) and described as type of *Physeter* (*Euphysetes*) *simus* Owen, 1866; skull gifted by the Superintendent, Trivandrum Museum to the British Museum (Natural History), No. 1952.8.28.2; specimen beached at Trivandrum on December 19th (no year) with a nine inch foetus — Hall and Kelson, 1959].

PAKISTAN [Mekran coast — Ahmad and Ghalib, 1975 and generally common in Pakistan waters — Roberts, 1977; one specimen stranded at Phitti Creek on Sind coast on 17th October 1981 — Mohd. Farooq Ahmad, 1982].

5. **Ziphius cavirostris** G. Cuvier, 1823

CUVIER'S BEAKED WHALE, GOOSE-BEAKED WHALE

Records:

SRI LANKA [*Sightings* — Trincomalee (E.P.) on 15th March 1983 — Alling, 1983 and 3 animals on 16th April 1983 — Leatherwood *et al.*, 1984; *strandings* — Goiyapana (S.P.), 14 feet in length on 20th August 1936; Dodanduwa (S.P.) on 10th January 1939; Colombo Harbour Break-water on 24th June 1939, off Ratmalana (W.P.) taken in a seine net about 200 yards from shore on 30th July 1940 and Telwatta near Hikkaduwa (S.P.) on 1st July 1963 — Deraniyagala, 1945, 1965b; a specimen $18\frac{1}{2}$ feet in length at Madihe, Matara (S.P.) in June 1967].

INDIA [Ellerman and Morrison-Scott, 1966] 1966].

PAKISTAN [Strandings observed on Pakistan coast — Mohd. Farooq Ahmad, 1982].

6. **Mesoplodon ginkgodens** Nishiwaki and Kamiya, 1958
Mesoplodon hotaula Deraniyagala, 1963

GINKGO-TOOTHED BEAKED WHALE

Records:

SRI LANKA [*Stranding* — single specimen, female, 14 feet 7 inches at Ratmalana (W.P.) on 26th January 1963 — Deraniyagala, 1963; a specimen caught off Trincomalee (E.P.) suspected to be of this species by Jim Mead — Leatherwood, 1985].

7. **Steno bredanensis** (Lesson, 1828)
Delphinus rostratus Desmarest, 1817, 160
Steno frontatus Blyth, 1863, 91
Steno frontatus Blanford, 1891. 582

ROUGH-TOOTHED DOLPHIN

Records:

INDIA [Nicobar Islands, Bay of Bengal — Blanford, 1891].

PAKISTAN [*Strandings* observed on Pakistan coast — Mohd. Farooq Ahmad, 1982].

GULF OF ADEN [Hershkovitz, 1966, 15].

8. **Sousa chinensis** (Osbeck, 1765)
Steno plumbeus Blanford, 1891, 583
Sotalia fergusoni Lydekker, 1903, 411

INDO-PACIFIC HUMP-BACKED DOLPHIN

Records:

SRI LANKA [Arippu, Mannar (N.P.) from a

skull gifted by Mr. Holdsworth in the Museum of the Royal College of Surgeons, U.K. — Blanford, 1891; Egodauyana (W.P.), an adult male on 3rd April 1934 taken in a seine net — Deraniyagala, 1945].

INDIA [*Sightings* — Malabar, 1837, van Beneden and Gervais, 1868; off Visakhapatnam, Andhra Pradesh on 18th September 1854-Owen, 1866; Calicut Harbour on 22nd December 1980, 4 animals — Harwood, 1980; north-east of Andaman Island, April 1982 — Leatherwood and Clarke, 1983; *strandings* — skull in the British Museum (Natural History), No. 1866.2.8.2. from Vizagapatam, Madras coast gifted by Sir Walter Elliot; Malabar coast — Blanford — 1891; Waltair, Vizagapatam, Madras (type locality) and Alibág, Bombay — Blanford, 1891; Trivandrum beach and described under *Sotalia fergusoni* — Lydekker, 1903; 2 skulls collected from Malabar coast in 1827 by Dussumier and a mounted specimen in Museum d'Histoire Naturelle, Laboratoire d'Anatomie Comparee, France; 2 skulls, Nos. M5965-6 in the Bombay Natural History Society — Pilleri and Gihr, 1973-74].

PAKISTAN [*Sightings* — observed in Sonmiani as well as near Gwadur — Roberts, 1977; *strandings* — Karachi — Blanford, 1891; 4 strandings in 1981 — at Rehri Creek on 20th March, at Cape Monze on 14th October, at Buleji coast on 15th October and at Korangi Creek on 7th November — Mohd. Farooq Ahmad, 1982].

GULF OF OMAN [*Sightings* — west point and south shore of Hormuz Island on 22nd and 30th January 1973 — 16 animals, 2 animals one mile from Dorgahan on 29th January 1973 — Pilleri and Gihr, 1973].

ARABIAN GULF [Female caught on the coast of Shuaikh Secondary School, Kuwait by fishermen in Spring 1962 and described as *Sotalia fergusoni* and a male in a branch of Khor-Al Zubair, Iraq waters by fishermen on 25th July 1967 — Al-Robbae, 1974; 1 skull, No. MC 47000 in Museum of Comparative Zoology, U.S.A., collected by H. Field on 5th June 1950 from west of Torit, Quatar — Leatherwood, 1985; 4 skulls and mandibles collected by M. D. Gallagher in British Museum (Natural History) — Pilleri and Gihr, 1972; one skull and ramus collected by M. D. Gallagher from Hower Island near Bahrain in January 1973 in the British Museum (Natural History)].

GULF OF ADEN [Skull No. 1962.7.19.1 in British Museum (Natural History) from Kwad, Abyan, west of Aden collected by C. A. Wright and a skull of a female collected by Hinds from Berbera, Somali Republic, No. 1954.9.9.5 — Pilleri and Gihr; Cranial box, No. 1955.2.23.1. from Havta, 210 miles east of Aden — Leatherwood, 1985].

RED SEA [Skull No. 1924.9.11.1, collected by W. A. Macfadyen in the British Museum (Natural History) on the east side of Great Bitter Lake, Suez Canal — Pilleri and Gihr, 1972 and a skull without mandibles, No. 1962.2.19.1. from the Red Sea in the British Museum (Natural History) — Leatherwood, 1985].

9. **Tursiops truncatus** (Montagu, 1821)

Tursiops aduncus Roberts, 1977, 316

BOTTLENOSE DOLPHIN

Records:

SRI LANKA [*Sightings* — Southwest Negombo (W.P.), off Chilaw breakwater, west of Udappuwa, west of Puttalam and south of Talawila (N.W.P.), southwest of Kudremalai Point, off Adam's Bridge (N.P.) — Leatherwood *et al.*, 1984; east coast — Alling *et al.*, 1983; *Collections* — 4 skulls in the British Museum (Natural History), from the Gulf of Mannar (N.P.) gifted by W.W.A. Phillips, from Karativu Island, Portugal Bay (N.W.P.) and from 50 miles north of Colombo and 5 miles from shore gifted by G. C. Beaumont; 4 skulls in

the Colombo Museum; common inshore in Negombo (W.P.) and Trincomalee (E.P.) — Lantz and Gunasekera, 1956; one specimen caught off Negombo — Joseph *et al.*, 1983; Beruwala (S.P.) — Alling and E. R. Tranchell; Trincolee (E.P.) — Alling and Prematunga *et al.*, 1985].

INDIA [*Sightings* — Travancore — Pillay, 1926; *strandings* — Trivandrum in March 1903 listed as *Tursiops catalania* — Leatherwood, 1985; *Collections* — skull from Vizagapatam, Madras, type of *Delphinus godamu* (Owen, 1866) gifted by Sir Walter Elliot; skull No. 1883.11.20.3. from India in the British Museum (Natural History) — Leatherwood, 1985; skeleton from Travancore collected in February 1908, type of *T. dawsoni* in the British Museum (Natural History); skull from Bay of Bengal, type of *D. eurynome* (Gray, 1846), 4 skeletons from Trivandrum, all in the British Museum (Natural History) — Leatherwood and Clarke, 1983; stuffed skin, type of *Delphinus perniger* in Museum of Asiatic Society, Calcutta — Hershkovitz, 1966].

PAKISTAN [Karachi-Blanford, 1891 and Ross, 1977; generally common in Pakistan waters in large herds — Pilleri, 1972 and Roberts, 1977; one specimen stranded at Sandspit on Sind coast on 22nd November 1981 — Mohd. Farooq Ahmad, 1982; 2 skulls, tympanic and periotic from Karachi in the British Museum (Natural History) — Leatherwood, 1985; skeletons from Point Monze and Clifton coast - Pilleri and Gihr, 1973-74].

GULF OF OMAN [Two strandings at Masirah and Ras Al Hadd — Ross, 1981; calvarium and mandible from Sur and calvarium from between Sur and Ras Al Hadd collected in 1977 & 1979 by M. D. Gallagher, 1980 and calvarium from Masirah Island in the British Museum (Natural History) — Leatherwood, 1985].

ARABIAN GULF [*Stranding* — one specimen from Ras Al-Mataf on 15th January 1974 — Al-Robbae, 1974; *Collections* — 2 skeletons from Muscat collected by A.S.G. Jayakar — Blanford, 1888 and 1891; 2 skulls from the Arabian Gulf and a skull and calvarium collected from the Trucial coast near Rasal Khaiman by M. D. Gallagher in the British Museum (Natural History); skeleton from Hormuz in the Pilleri collection — Pilleri and Gihr, 1973-74].

GULF OF ADEN [skeleton of a male from Djibouti collected by J. N. Rose in Museum National d'Histoire Naturelle, Laboratoire d'Anatomie Comparee, Paris — Leatherwood, 1985; Berbera, Somali Republic, 2 skulls gifted by A. Fraser Brunner and 2 skulls collected by V. T. Hinds in the British Museum (Natural History) — Leatherwood, 1985.

RED SEA [Belhoss Islands and type locality of *Delphinus abusalam* Rüppel and *D. hamatus* Weigmann, 1841; Mounted skin with skull inside, Type — *D. abusalam,* collected in 1833 by E. Rüppel and a skull collected in 1842 in Senckenberg Naturmuseum — Leatherwood, 1985].

10. **Delphinus delphis** Linnaeus, 1758

Delphinus frithii Blyth, 1859, 492
Delphinus pomeegra Owen, 1866, 23

THE COMMON DOLPHIN

Records:

SRI LANKA [*Sightings* — Kalpitiya (N.W.P.) and Trincomalee (E.P.) — Nevill, 1887; Batticaloa Lagoon (E.P.) — Nevill, 1887; abundant especially around Negombo (W.P.) and Trincomalee (E.P.) during the fishing season — Lantz and Gunasekera, 1956; off Sri Lanka — Alling, 1983; 10 animals on 27th November 1984 off Sri Lanka, Musee Oceanographique — Leatherwood, 1985; 2 skulls in the Colombo Museum].

MALDIVE ISLANDS [Water worn skull without lower jaw on Furadi Island — Deraniyagala, 1956].

INDIA [Madras coast — Blanford, 1891; skull in Calcutta Museum gifted by R.W.G. Frith and described by Blyth under the name of *Delphinus frithii,* skull in the British Museum (Natural History) of a specimen from the Madras coast collected by W. Elliot and described by Owen, 1866 under the name, *Delphinus pomegra*; 6 males and 4 females caught off Calangute, Goa — Thomas, 1983].

11. **Delphinus capensis** Gray, 1828

CAPE DOLPHIN

Records:

PAKISTAN [*Sightings* — off Cape Monze and Karachi — Ahmad and Ghalib, 1975; schools feed inshore — Roberts, 1977 and generally observed in Pakistan coastal waters — Mohd. Farooq Ahmad, 1982; *stranding* — one specimen stranded at Hawk's Bay on Sind coast on 15th October 1981 — Mohd. Farooq Ahmad, 1982].

Remarks: The only differences to be observed in Robert's description of *D. capensis,* separating it from *D. delphis* recorded from the Madras coast and from Sri Lanka are the presence of 54 to 58 teeth in each tooth row and longitudinal grey and yellow bands on the flanks in *D. capensis. D. delphis* is described to possess 40 to 55 teeth in each tooth row and without the bands on the flanks. However, Burton (1976) and Martin (1977) have described *D. delphis* as having grey and yellow and white undulating stripes on the flanks. Roberts (1977) also states that the Karachi specimens have been assigned by Pilleri to the species *tropicalis* van Bree. This puzzle can only be resolved by a study of living *tropicalis.*

12. **Delphinus tropicalis** van Bree, 1972

Delphinus longirostris Cuvier, 1829
Delphinus dussimieri Blanford, 1891

DUSSUMIER'S DOLPHIN, LONG-NOSED DOLPHIN

Records:

SRI LANKA [Skull, No. 15 B in the Colombo Museum, exact locality unknown].

INDIA [Malabar coast — G. Cuvier, 1829, skull in the Museum National d'Histoire Naturelle, Laboratoire d'Anatomie Comparee, Paris; 2 skeletons in the Bombay Natural History Society from Malabar coast — Pilleri and Gihr, 1973-74].

PAKISTAN [*Stranding* — one stranding at Buleji on Sind coast on 15 October 1981 — Mohd. Farooq Ahmad, 1982].

GULF OF OMAN [Skull from Ras Al Hadd in Zoological Museum, Amsterdam-Ross, 1981].

ARABIAN GULF [Skull from Muscat collected by Petty Officer Wright, skull from Arabian Gulf and another skull from Umm Al Quauwain lagoon and skull from Ajman Creek near Sharjan, collected by M. D. Gallagher and a skull from Ras Al Khaimah, United Arab Emirates and all in the British Museum (Natural History)].

GULF OF ADEN [Skull of a specimen caught off Berbera, Somali Republic on 16th February 1953 and a skull and postcranial skeleton of a specimen caught on 18th February 1953 from the same locality in the British Museum-van Bree, 1972; skull collected from Djibouti by J. N. Ross in Museum National d'Histoire Naturelle, Laboratoire d'Anatomie Comparee, Paris — Leatherwood, 1985].

13. **Stenella attenuata** (Gray, 1846)

SPOTTED DOLPHIN

Records:

SRI LANKA [A specimen harpooned at sea between Ceylon and the equator described

under *Delphinus velox* by Cuvier, 1829 and Blanford, 1891; mounted specimen collected by Dussumier in Museum National d'Histoire Naturelle, Laboratoire d'Zoologie, France, type of *Delphinus velox*; *sightings* — Koddiyar Bay, Trincomalee (E.P.) on 28th February 1983; south end of Puttalam lagoon (N.W.P.) on 4th March 1983, 275 and 100 animals respectively; off northern coast 250 to 350 animals on 16th April 1983 — Leatherwood *et al.*, 1984; east coast, 3 herds — Alling *et al.*, 1983 and caught between 9th February 1983 and April 1985; 43 males and 39 females from off Beruwala (S.P.) and Trincomalee (E.P.) — Alling and Prematunga *et al.*, 1985; skull in Colombo Museum and two skulls in NARA Museum, Colombo].

INDIA [Bay of Bengal — Gray, 1846 as *Steno attenuatus* and by Beddard in 1900 as *Prodelphinus attenuatus*; Sundarban Islands, Bay of Bengal as *Delphinus malayanus* — Blanford, 1891; *sighting* — on 13th April 1983 in northern Bay of Bengal — Leatherwood *et al.*, 1984; skull collected by Mrs. Ince in British Museum (Natural History)].

MALDIVE ISLANDS [*Sightings* — 75 to 80 animals from 19th to 21st April 1983 — Leatherwood, 1984].

GULF OF OMAN [Calvarium and rostrum collected by M. D. Gallagher from near Siham, Batinia coast and from Sur].

RED SEA [Leatherwood and Reeves, 1983, 234].

14. **Stenella longirostris** (Gray, 1828)

Delphinus microps Gray, 1846
Delphinus alope Gray, 1846

LONG-SNOUTED SPINNER DOLPHIN

Records:

SRI LANKA [In British Museum (Natural History) under *Stenella microps* (i) skull and skeleton from Trincomalee (E.P.) gifted by Hugh Nevill, (ii) skull and skeleton of a female, twenty miles north of Colombo gifted by G. C. Beaumont, (iii) skull and scapulae of female from 50 miles north of Colombo and (iv) skull of a female from the west coast of Sri Lanka gifted by Dr. W. C. Osman-Hill; *sightings* — frequents northwest coast of Ceylon — Holdsworth 1872; southwest of Yala on 3rd February 1970 — Leatherwood and Clarke, 1983; Koddiyar Bay on 28th February 1983, 100 animals on 15th April 1983 just north of Sri Lanka, approximately 200 animals on 16th April 1983 off Trincomalee (E.P.) — Leatherwood *et al.*, 1984; east coast of Sri Lanka — Alling *et al.*, 1983; caught off Negombo and Colombo — Joseph *et al.*, 1983; Beruwela (S.P.) — Alling and E. R. Tranchell; Galle (S.P.) — Leatherwood, 1985; off Trincomalee (E.P.) — Alling, Prematunga *et al.*, 1983; East coast — Tulip Expedition; *Collections* — Skull from Arippu in the Museum, College of Surgeons, Colombo and 5 skulls from specimens off Trincomalee gifted by E. C. Fernando in the Field Museum of Natural History, Chicago.

INDIA [Photograph of skull (illustration) taken prior to 1827 from Malabar in U.S. National Museum files — Leatherwood, 1985].

MALDIVE ISLANDS [*Sightings* — Guadu, Miladummadulla Atoll, south Male Atoll — Leatherwood, 1984].

GULF OF OMAN [Calvarium from Sur Oman and skull between Sur and Ras Al Hadd collected by M. D. Gallagher and skull from Sur, Masirah Island collected by T. D. Rogers in the British Museum (Natural History)].

GULF OF ADEN [Skeleton in Museum National d'Histoire Naturellae, Laboratoire d' Anatomie Comparee, Paris collected from Djibouti by J. N. Rose — Leatherwood, 1985].

RED SEA [Skull in Field Museum of Natural History, Chicago, U.S.A. collected by D. Osborn on coast north of Mersa Alam, Egypt].

15. **Stenella coeruleoalba** (Meyen, 1833)

STRIPED DOLPHIN

Records:

SRI LANKA [*Sightings* — off the east coast — Alling *et al.*, 1983; caught off Negombo (W.P.), 2 males on 18th November 1982 and 11th January 1983 — Joseph *et al.*, 1983; Beruwela (S.P.) on 9th May 1983 — Alling and E. R. Tranchell from 5th January to 25th May 1985; 94 animals and 10 males and 13 females off Trincomalee from 15th March 1983 to April 1985 — Prematunga *et al.*, in press].

MALDIVE ISLANDS [*Sightings* — northeast on 19th April 1983 — Leatherwood *et al.*, 1984].

GULF OF OMAN [Calvarium collected from Sawagq on 26th November 1977 by M. D. Gallagher in the British Museum (Natural History — Leatherwood, 1985].

16. **Grampus griseus** (G. Cuvier, 1812)

RISSO'S DOLPHIN

Records:

SRI LANKA [*Sightings* — northeast coast about 150 animals on 16th April 1983 — Leatherwood *et al.*, 1984; off Sri Lanka — Alling *et al.*, 1982 and east coast, 6 sightings — — Alling, 1983; *caught* off Negombo one male specimen on 8th October 1982 — Joseph *et al.*, 1982; 67 animals from January 1983 to March 1985 off Trincomalee — Alling and Prematunga *et al.*, 1985; Beruwala (S.P.) from 9th May 1983 to 25th May 1985, 108 animals — Alling and E. R. Tranchell].

MALDIVE ISLANDS [Off Male Atoll, 4 to 6 animals — Leatherwood, 1984].

GULF OF OMAN [Skull from Ra Sallin, Batimah, a rib, vertebra and a mandible collected from Qurm,ur Muscat by M. D. Gallagher and two skeletons from Muscat collected by A.S.G. Jayakar in the British Museum (Natural History); skull from Ras Al Hadd in the Zoological Museum, Amsterdam — Leatherwood, 1985].

RED SEA [Calvarium collected by G. W. Graham from coast — Leatherwood, 1985].

17. **Peponocephala electra** (Gray, 1846)

Delphinus fusiformis Owen, 1866
Lagenorhynchus electra True, 1889
Lagenorhynchus obscurum Blanford, 1891
Lagenorhynchus electra Roberts, 1977
Lagenorhynchus obscurus Phillips, 1980

MELON-HEADED WHALE

Records:

SRI LANKA [Skull from Palk Strait in Calcutta Museum — Blanford, 1891].

INDIA [Madras, type locality of *Delphinus* (*Lagenorhynchus*) *fusiformis* Owen, 1866 and type skull collected by Sir Walter Elliot in the British Museum (Natural History) from Vizagapatam, Madras; Bierman and Slijper, 1947].

PAKISTAN [*Sightings* — seen regularly off Mekran coast but usually after the end of the monsoon and during the winter months when the Mekran coastal waters provide a particularly rich fishing ground — Dr. Ranjha and generally common in Pakistan waters — Roberts, 1977; *strandings* — 2 strandings, one at Cape Monze on 14th October 1981 and the other at Rehri Creek on 20th March 1982.

18. **Globicephala macrorhynchus** Gray, 1846

G[lobicephala] indica Blyth, 1852
Globicephalus indicus Blanford, 1891
Globicephala sp. Deraniyagala, 1945

SHORT-FINNED PILOT WHALE

Records:

SRI LANKA [From a fossil vertebra collected by Colonel S. D. Cleve of the Royal Engineers when digging at Promontery known as Flag-

staff Battery, Colombo at a depth of 15 feet and from 100 yards from shore — Deraniyagala, 1945].

INDIA [2 specimens out of a shoal of several dozens found stranded in Hooghly River, near Serampore, West Bengal in July 1852; dozens near Salt Lakes, Calcutta in 1950 — Jones, 1953; salt or brackish water of the Gangetic Delta — Blanford, 1891].

19. **Feresa attenuata** Gray, 1874

PYGMY KILLER WHALE

Records:

SRI LANKA [*Sightings* — Alling, 1983; *caught* off Trincomalee, 3 animals on 8th February and 3rd April 1983 — Alling; and Beruwala, 8 animals — E. R. Tranchell].

GULF OF OMAN [*Sighting* close to Oman coast — Harwood, 1980].

20. **Pseudorca crassidens** (Owen, 1846)

FALSE KILLER WHALE

Records:

SRI LANKA [*Sightings* — off northeast coast in April 1982 — Leatherwood and Clarke, 1983; off the east coast on 16th April 1983 — Alling *et al.* (1983); 25 to 30 animals on northeast coast — Leatherwood *et al.*, 1984; caught off Moratuwa (W.P.) in December 1980, complete skeleton in Colombo Museum and 167 specimens stranded at Kambanturai at Kayts (N.P.) on 3rd August 1929 — Pearson, 1930; 97 specimens stranded at Mutur (E.P.) on 10th November 1934, a single specimen at Godavaya (S.P.) on 30th September 1939 and another specimen at Chempianpattu (N.P.) on 28th January 1954 — Deraniyagala, 1960].

INDIA [South of India — Pearson, 1930; Male and female stranded at Trivandrum in February 1902 — Pillay, 1926; male and female at Pozhikara, Cape Comorin, Trivandrum — Silas and Pillay, 1960; Puthiappa, north of Calicut on 28th July 1975 — Mohan *et al.* 1984; from Port Blair, Andamans, caught on 27 July 1976 — James, 1984; specimen from Gulf of Cambay, Maharashtra in August 1978 by V. M. Raval in Institute of Science, Navsari; Rameswaram, Gulf of Mannar on 18th October 1975 — Thiagarajan *et al.*, 1984; skeleton from Travancore in British Museum (Natural History) — Leatherwood, 1985].

PAKISTAN [A specimen stranded at Phitti Creek on Sind coast on 17th October 1981 — Ahmad, 1982].

GULF OF OMAN [Skull from Khasab, north Oman collected by Royal Geographic Society and part of a right ramus from Masirah Island collected by M. D. Gallagher in British Museum (Natural History) — Leatherwood, 1985].

ARABIAN GULF [One specimen at Dowha at 40 km, south of Kuwait in muddy area in 1964, skeleton in Kuwait Natural History Museum — Al-Robbae, 1974].

21. **Orcinus orca** (Linnaeus, 1758)

KILLER WHALE

Records:

SRI LANKA [Sightings — west coast, April 1868 — Blanford, 1891; off Chilaw (N.W.P.) — Holdsworth, 1872].

INDIA [Sighting of one animal north of Andamans on 12th April 1983 — Leatherwood *et al.*, 1984; *stranding* of specimen at Armada, Baroda State in 1943 — S. T. Moses, 1948; skull from Nicobar Island in Bombay Natural History Society — Pilleri and Gihr, 1973-74].

PAKISTAN [Strandings recorded — Mohd. Farooq Ahmad, 1982].

GULF OF ADEN [Large male off Rashafun on 29th April 1982 by Jeremiah and Sullivan — Leatherwood, 1985].

22. **Orcaella brevirostris** (Gray, 1866)

IRRAWADY DOLPHIN

Records:

INDIA [Type locality, Vizagapatam, Madras, Bay of Bengal, type skull collected by Sir Walter Elliot in British Museum (Natural History); Ganges river, 70 to 80 metres upstream, Bay of Bengal — Anderson, 1871; ascending rivers as far as the tide extends — Blanford, 1891; Bay of Bengal probably the western extreme of its range — Leatherwood and Reeves, 1983].

23. **Neophocaena phocaenoides** (G. Cuvier, 1829)

Delphinapterus molagen Owen, 1866
Neomeris kurrachiensis Murray, 1884
Neomeris phocaenoides Roberts, 1977

FINLESS PORPOISE

Records:

SRI LANKA [a specimen caught, 670 mm in length, by Smithsonian Carangid Survey Team on 20th March 1970 from the Wadge Bank, alcohol specimen in Museum of Comparative Zoology, Mass, U.S.A.].

INDIA [*Caught* — a juvenile specimen in a gill net in February 1973, 669 mm in length from Calicut — Balan, 1976; 7 males and 10 females off Calangute, Goa between 4th October 1973 to 4th April 1978 — Thomas, 1983; 17 animals off south Canara coast and one animal off Calicut — Dawson, 1957, 1959; *skulls and skeletons* — skulls collected in 1827, an incomplete skeleton and a mounted specimen collected by Dussumier from Malabar coast in the Museum National d'Histoire Naturelle, Laboratoire d'Anatomie Comparee — Gray, 1846; Madras, type locality of *Delphinapterus molagen* Owen, 1866; skull from Travancore collected by Ferguson in British Museum (Natural History) and skull and foetus from mouth of Bombay Harbour in British Museum (Natural History) — Pilleri and Gihr, 1972; skeleton from Trivandrum in Trivandrum Museum — Lydekker, 1908; 3 skulls in Bombay Natural History Society from Malabar coast].

PAKISTAN [7 skulls from Gadani, Sonmiani Bay, 2 skulls from Milutu Camp, Sonmiani Bay, skull from Gizri village, skull from Rehri Creek, skull from Kudri Creek, skull from Edrahym Hydari, 2 skulls from Dahm, Sonmiani Bay and skull from Sonmiani Bay in Pilleri collection — Pilleri and Gihr, 1972; *stranding* — one specimen at Korangi Creek on Sind coast on 3rd November 1981 — Mohd. Farooq Ahmad, 1982; Karachi — Murray, 1884 as *Neomeris kurrachiensis*; *sightings* — common on Pakistan coasts and in the Indus mouth frequenting Kudi, Mull, Khai and Dubla Creeks — Pilleri, 1972; common along the Mekran coast from late September to April frequenting the Mangrove creeks and inlets, sighted around Sonmiani Hor in Les Belas and in the estuary of the Hingol River in the Mekran — Roberts, 1977; Sind and Baluchistan coasts — Ahmad and Ghalib, 1975].

ARABIAN GULF [One dead male, 37 km south of FAO in Iraq Territorial waters on 2nd May 1974 and one female caught by fishing trawler from FAO area on 15th April 1975 — Al-Robbae, 1975].

24 **Eubalaena australis** Desmoulins, 1822

SOUTHERN RIGHT WHALE

Records:

INDIA [One specimen stranded at Gajana, Baroda State in 1944 — S. T. Moses, 1948].

25. **Balaenoptera musculus** (Linnaeus, 1758)

Balaenoptera indica Blyth, 1859
Sibbaldus musculus Deraniyagala, 1948

BLUE WHALE

Records:

SRI LANKA [Coasts of Ceylon — Blanford, 1891; *sightings* — a sixty foot female on 23rd

January 1946 in Trincomalee Harbour by Capt. Mount Haes; east of Trincomalee on 16th October 1983, a small animal — Whitehead, 1983; 16 animals at Koddiyar Bay, Trincomalee on 28th February 1983 and an adult with accompanying calf in May 1983 at Foul Point near Trincomalee — Leatherwood *et al.*, 1984; on 7th May 1985 off Dondra (S.P.) — Gunaratne, 1985; *strandings* — Ambalangoda (S.P.) in September 1894, 65 feet in length — Haly, 1894 (skeleton in Colombo Museum); a male on 26th May 1932 in Tamblegam Bay and another specimen in Koddiyar Bay, Trincomalee on 30th June 1932, length 66 feet approx. — Pearson, 1932; Nirodumnai, 35 feet in length in 1932 — S. T. Moses, 1947; Polhena, near Matara (S.P.) on 6th February 1934 (Plate 1) — Malpas; Dodanduwa (S.P.) on 10th January 1939 — Deraniyagala, 1965; Bambalapitiya (W.P.) on 8th April 1949 — Deraniyagala, 1960; Kokkilai near Pulmoddai (E.P.) on 14th April 1965, Wellawatte (W.P.) on 3rd April 1965 and Galle Face, Colombo (W.P.) in March 1976, carcases of a mother and calf — P.H.D.H. de Silva; on 9th February 1984, Chilaw (N.W.P.), Fernando, 1981].

INDIA [Jaw bone from off Sordip Bay, Bay of Bengal of *Balaenoptera indica* — Blyth, 1859; skeleton in Madras Museum from Mangalore collected in 1874 — S. T. Moses, 1947; Bay of Bengal and coast of Malabar — Blanford, 1891; *strandings* — near Bombay, Thana District on 11th April 1906, length 63 feet — Millard, 1907; a 61 feet blue whale stranded at Viziadurg near Ratnagiri in August 1912, a whale over 80 feet near Charai, Cochin in November 1927, between Suratkal and Moolki in 1939 and at Mulvel, Okhamandel in March 1939 — S. T. Mosses, 1947; Jambudwip, Bengal coast in January or February 1934 — S. Jones, 1953; near Magdalla, Port Surat, Gujarat, a whale 66 feet in length — J. C. Daniel, 1963; On 7th December 1960 and on 1st December 1980 at Ganeshgram village, Gujarat and a 11.26 m female at Tuticorin on 2nd April 1969 — James, 1983; Muloor village, South Kanara — Nagabhuganam and Dhulked, 1964 and Calicut — Venkataraman and Girija Vallabhan, 1968].

PAKISTAN [*Sightings* — shallow waters of Mekran coast — Roberts, 1977; *strandings* — Clifton Beach, 1879 — Murray, 1884 and several strandings on the Sind coast — Blanford, 1891; parts of skeleton from Juddi near Pasni, Mekran coast in 1965 and a specimen of about 60 feet stranded about 5 miles west of Pasni, and a skeleton in the Zoological Survey of Pakistan, 70 feet in length — Siddiqi, 1967 and common on Baluchistan coast — Mohd. Farooq Ahmad, 1982].

ARABIAN GULF [Iraq — Nuri Mahdi and P. V. Georg, 1969; Kuwait, a dead whale entangled in a submarine telegraph cable, skeleton mounted in the Kuwait Natural History Museum and at Kadguma on the Kuwait coast in muddy area on 6th June 1963, skeleton in Shuaikh Secondary School — Al-Robbae, 1974].

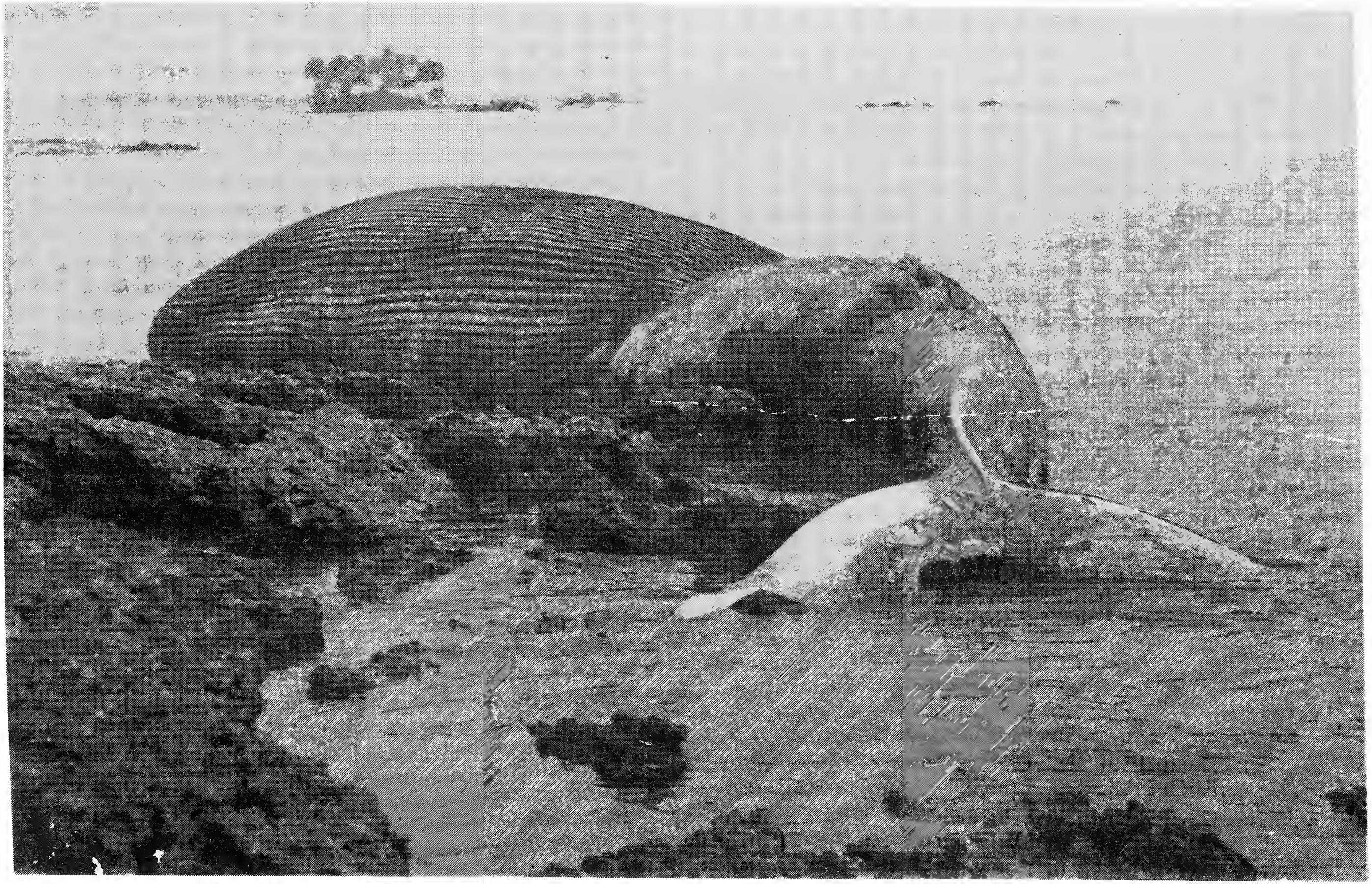
26. **Balaenoptera physalus** (Linnaeus, 1758)

FIN WHALE

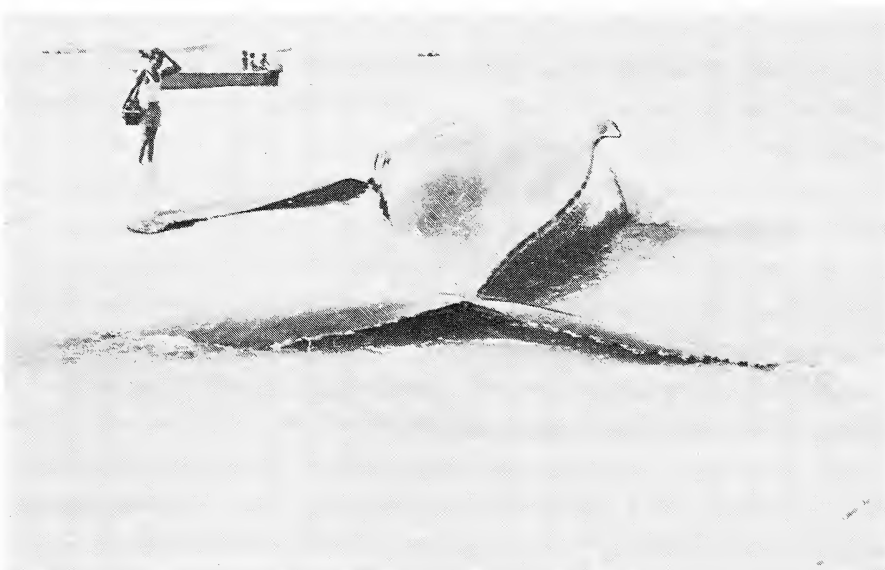
Records:

SRI LANKA [*Strandings* — Chilaw (N.W.P.) in August 1910 — H.S. Fernando, 1912; Bambalapitiya, Colombo (W.P.) in February 1934, Chilaw (N.W.P.) in August 1934, Bambalapitiya (W.P.), one on 1st June 1934 and another specimen at Ariyalai, Jaffna (N.P.) on 7 June 1949 — Deraniyagala, 1960; Uswetikeiyawa, Colombo (W.P.) on 11th August 1971, 45 feet in length — P.H.D.H. de Silva, 1983].

INDIA [5 vertebrae in the Medical College, Calcutta under the name, *Balaenoptera blythi* — Anderson, 1879; *strandings* — at Umargam, 100 miles from Bombay, 68 feet in length on



Carcase of *Balaenoptera musculus*, the Blue Whale beached at Polhena, near Matara (S.P.), Sri Lanka, on 6th February, 1934.



Two photographs of *Megaptera novaeangliae*, the humpback whale on Chilaw beach (N.W.P.), Sri Lanka, on 22nd January 1981.

14th May 1951 — V. K. Chari, 1951 and confirmed by J. C. Daniel, 1963; at Dhabool, 97 miles south of Bombay — Prater, 1913 as *B. indica*; off Arnala, west of Virar, 40 km north of Bombay, about 48 feet and with 68 throat furrows on 6th August 1965 and a specimen stranded among rocks at Nepean Seaface, Bombay, about 50 feet in length — Grubh and Pereira, 1965].

PAKISTAN [Sightings — Baluchistan coast — Ahmad and Ghalib, 1975; *strandings* observed — Roberts, 1977 and Mohd. Farooq Ahmad, 1982; young specimen ensnared by local fishermen in July 1969 in their nets near Astola Island, length about 35 feet, and towed back to Karachi but later released to the sea by Dr. M. S. Siddiqi — Roberts, 1977].

ARABIAN GULF [Two incomplete skeletons in the University Zoological Museum, King Saud University, Riyadh, Saudi Arabia, probably of mother and calf from Dhahran coast, around 1970 — P.H.D.H. de Silva].

27. **Balaenoptera acutorostrata** Lacépede, 1804

Balaenoptera acutorostrata bonaerensis Deraniyagala, 1960

Balaenoptera acutorostrata thalmaha Deraniyagala. 1963

MINKE WHALE

Records:

SRI LANKA [*Strandings* — Mannar (N.P.) on 19th May 1937, length 21 feet; Chempianpattu, Jaffna on 28th January 1954, male, 26 feet in length; 5 carcases off Jaffna (N.P.) at Kayts, Analativu, Velani East and Delft west from 3rd to 12th November 1962 measuring 28 feet, 35 feet, 30 feet, 30 feet and 30 feet respectively, skeleton and scapula in Jaffna Museum — Deraniyagala, 1948, 1954 and 1963].

INDIA [Bay of Bengal — Ellerman and Morrison-Scott, 1966].

RED SEA [Stranding of a specimen, 20 km south of Jizan, Saudi Arabia in May 1969 — Leatherwood, 1985].

28. **Balaenoptera borealis** Lesson, 1828

SEI WHALE

Records:

INDIA [Naduvattum, Kerala, an individual 45 feet in length with 45 throat furrows — P. K. Jacob and Devdas Menon, 1947 and confirmed by J. C. Daniel, 1963; at Pullamadan, near Mandapam Camp, a specimen about 50 feet — Venkataraman, Dorairaj, Devaraj and Ganapathi, 1973].

29. **Balaenoptera edeni** Anderson, 1878

BRYDE'S WHALE

Records:

SRI LANKA [*Sightings* — Known from sightings recorded recently by Leatherwood and Clarke, 1983, Leatherwood *et al.*, 1984 and Gunaratne and Obeysekera, 1985 from north of Trincomalee, 7 animals, near Koddiyar Bay, 2 animals, off south shore Talaimannar (N.P.) and east of Adam's Bridge (N.P.), Trincomalee Harbour and off Dondra (S.P.)].

INDIA [Bay of Bengal — Blanford, 1891].

PAKISTAN [Strandings observed — Mohd. Farooq Ahmad, 1982].

ARABIAN GULF [A specimen stranded in 1967 near Iraq port on island in front of Um Qasr, male, 41 feet and also a possible stranding in Kuwait — Nuri Mahdi, 1974 and a reference by P. Neve, 1973, particulars not available to author].

RED SEA [Near Tor, on the Sinai Peninsula in 1893, skeleton in the British Museum (Natural History) — Nuri Mahdi, 1967 and common — J. G. and P.R.G. Gasperetti, 1981].

30. **Megaptera novaeangliae** (Borowski, 1781)
HUMPBACK WHALE

Records:

SRI LANKA [*Sightings* — off Colombo (W.P.) in winter 1846 — Wray and Martin, 1980; Colombo Harbour, mother and calf on 22nd February 1949 — Deraniyagala, 1960; Gulf of Mannar (N.P.) — Wray and Martin, 1980 and Alling *et al.*, 1982; *stranding* of Chilaw (N.W.P.) of a specimen after being entangled in fishermen' nets on 22nd January 1981, length thirty-nine and half feet (Plate 2) — P.H.D.H. de Silva, 1983].

INDIA [Stranding at Anjengo, Travancore on 23rd January 1943, entangled in seine net — Mathew, 1947].

PAKISTAN [A specimen entangled in the telegraph-cable and drowned off the Baluchistan coast in July 1873 and a sight record off the mouth of Indus, probably of this species — Blanford, 1891; strandings observed — Mohd. Farooq Ahmad, 1982].

ARABIAN GULF [Gervais, 1883; skeleton and calvarium from Bassore Bay in Museum National d'Histoire Naturelle, Paris; a vertebra and rib probably of a specimen killed by a Turkish gun boat in the Shatt — Al Arab in Iraq Museum probably of this species — R. Hatt, 1959 and referred to by Al-Robbae, 1974].

Discussion

In this paper a total of thirty Cetacean species are described. Of these, records from off Sri Lanka total 23 species, 24 species from off India and 17 species from off Pakistan. The remaining records include 10 species from the Gulf of Oman, 9 species from the Arabian Gulf, 6 species from the Gulf of Aden and 7 species from the Red Sea. These records are based on sight records, strandings of individuals and mass stranding and skull and skeletal material in Museums and institutions. There are 3 instances of mass strandings namely, (1) 167 individuals of *Pseudorca crassidens* stranded near Kambanturai at Kayts, (2) 97 individuals stranded at Mutur, and (3) dozens of the Indian Pilot whale, *Globicephala macrorhynchus* stranded in the Salt Lakes, Calcutta. Two instances of multiple strandings are recorded which involve 5 specimens of *Balaenoptera acutorostrata* off the north of Sri Lanka and 2 individuals of *Pseudorca crassidens* off Pozhikara, Cape Comorin, Tamil Nadu.

In figures 1 and 2 strandings of large whales where dates are available are shown. For simplification the twelve months have been separated in these figures to two half-yearly periods referred to as Southern Winter and Southern Summer. Figure 1 gives the monthly strandings from April to March of the following year of all strandings where dates are available and Figure 2 shows the monthly strandings in respect of 4 species, *B. musculus*, *B. physalus*, *Megaptera novaeangliae* and *Physeter macrocephalus.* There is no indication that there is a seasonal peak in the strandings, though a peak is indicated for January.

It is generally considered that *Balaenoptera musculus, B. physalus* and *M. novaeangliae* show seasonal migratory pattern (MacIntosh 1966, Dawbin 1966). Baker (1972) states that *B. borealis* and *B. edeni* spend a shorter summer in the Antarctic waters and the rest of the year in the tropics. The records of strandings of both *Megaptera novaeangliae* and *Physeter macrocephalus* are insufficient for any statistical analysis but the available records for *B. musculus* and *B. physalus* appear to indicate the presence of such a seasonal pattern for the greater number of their strandings have occurred when they were in the tropics during southern winter. There are also the instances of the cow and calf of *B. musculus* being cast ashore at Galle Face, Colombo and of a cow

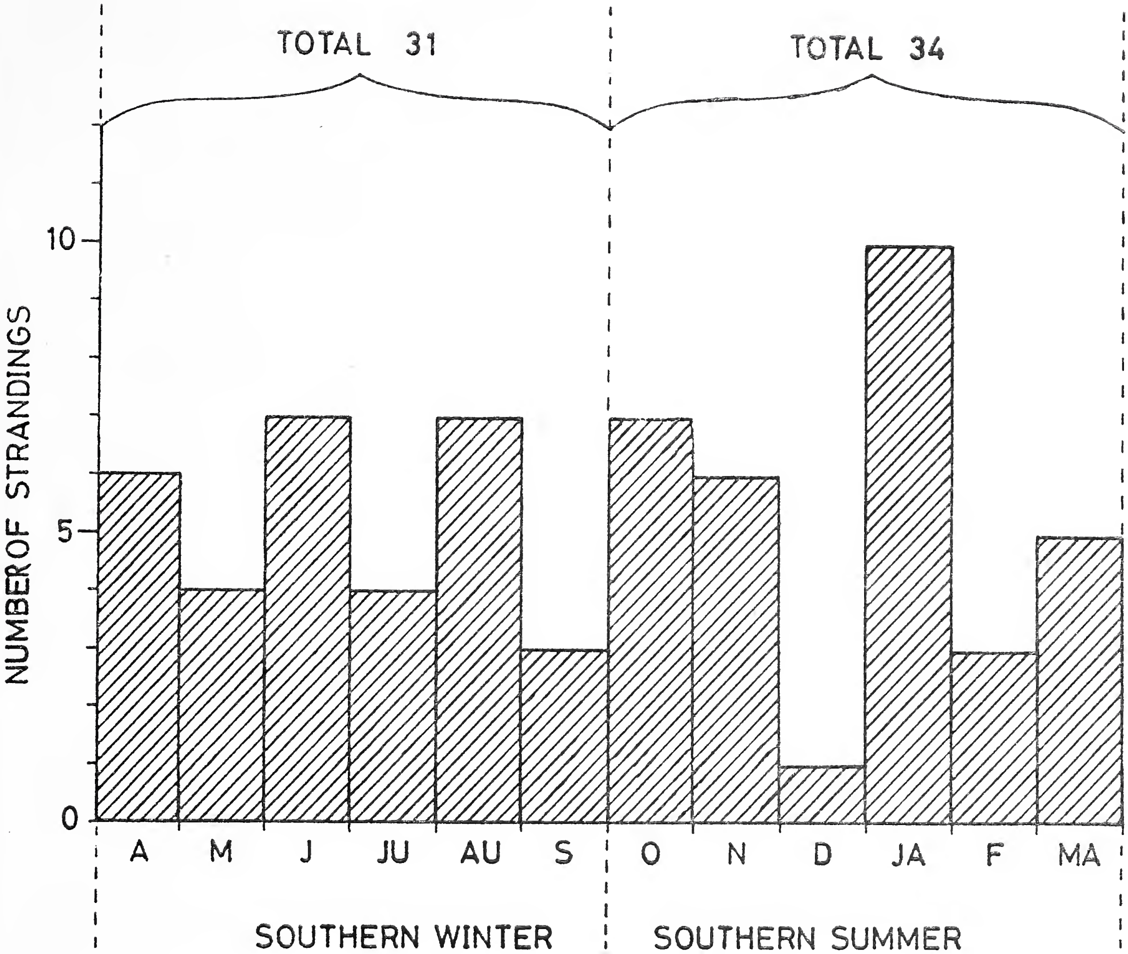


Fig. 1. Histogram showing the monthly strandings (April to following March).

of the same species returning to Trincomalee Harbour after it had been towed out to sea to give birth to a calf, all these instances coinciding with the period they normally spend in the warm tropical and subtropical waters. The data shown in figure 2 also indicates a lower peak in stranding at least for *B. musculus* and *B. physalus* from January to March, i.e. during the southern summer. This appears to suggest that a certain percentage of individuals arriving in the warmer subtropical and tropical waters continue to linger after the majority of their members have returned to the polar and subpolar seas for feeding.

A research team consisting of Dr. Hal Whitehead, Dr. Roger Page and Dr. Stephen Slater, members of the Tulip Expedition have been studying the larger whales, especially the Blue and Sperm Whales off the east coast of Sri Lanka under the auspices of the world

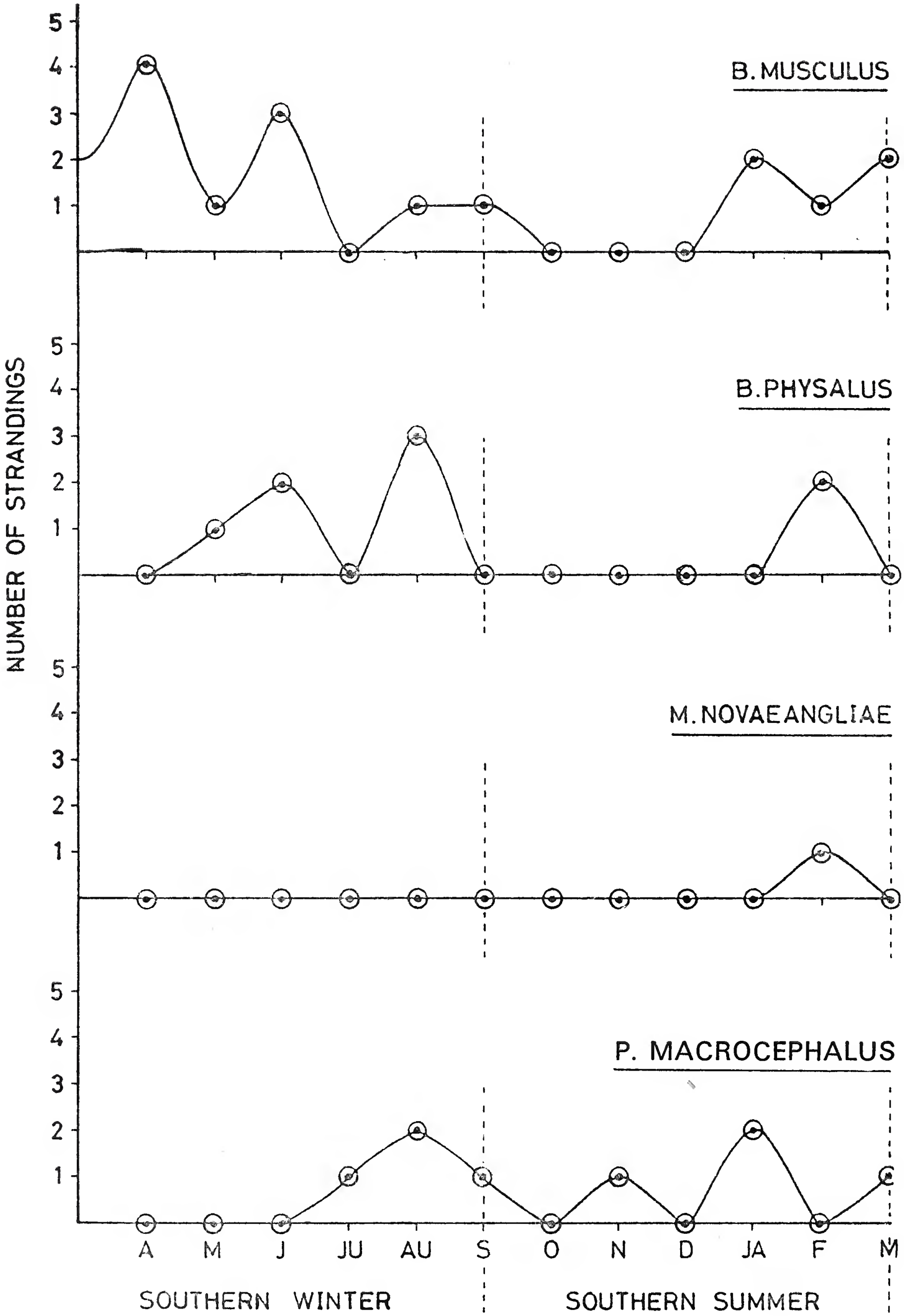


Fig. 2. Shows the monthly strandings (April to following March) in the Region in respect of *Balaenopteras musculus, B. physalus, Megaptera novaeangliae* and *Physeter macrocephalus*.

Wild Life Fund during the past few years. They have observed these whales off the east coast, particularly off Trincomalee during most parts of the year. Recently they have observed a Sperm Whale, about 20 metres in length, giving birth to a calf ("Ceylon Daily News" of 6th December 1983). These scientists now consider the east coast of Sri Lanka to be a calving ground for the larger whales during March to October during the year. Could it be that individuals which linger without returning to the polar and subpolar regions during the southern summer account for the individuals seen by the Tulip Expedition or is there a small breeding population of both Blue and Sperm Whales as suggested by the Tulip Expedition. It will be sometime before we will be able to know the actual position.

According to Norman and Fraser (1948) the Humpback Whale is "coast-loving in its habits, frequenting bays and inlets and it may be for this reason that so few get into difficulties in shoal water." The cow and calf seen by Deraniyagala in the Colombo Harbour eventually returned to the sea without mishap, and the death of the specimen off Chilaw was a result of entanglement in fishermen's nets and being dragged ashore by fishing vessels.

The data on Sri Lankan strandings discussed in this paper, meagre as these are, show that while equal number of strandings have occurred of the Blue Whale on both east and west coasts all the strandings of the Fin Whale and Sperm Whale have occurred on west and southern coasts and none on the east coast. This appears to suggest that while the east coast appears to be favourable for their life and movements the southern and west coasts specially with their fringing reefs provide much hazards to these two species. The strandings of Blue Whale, however, cannot be explained by unfavourable shore line configuration alone.

Several causes have been suggested to explain stranding in the Cetaceans but no single explanation provides a satisfactory answer. Several of the causes suggested are, (1) failure of its echolocation system (Dudock van Heel 1966), (2) tempted to shallow water by food, coastal migration or of offshore species staying too close to shore (Geraci), (3) the presence of an element of suicide (Geraci), (4) some form of reproductive urge to move to coastal water (Deraniyagala 1948), (5) harassed or chased by a predator, (6) frightened by unfamiliar underwater sounds, (7) following an ailing leader, (8) disoriented by disease with loss of equilibrium (many cases of infestation by trematodes in brain, around spinal cord, lungs, head sinuses, ear etc.) — Geraci, Ridgeway and Dailey 1972, Dailey and Walker 1978, Dailey and Stroud 1978, (9) disturbance in the social order (Geraci), (10) travelling an ancient migratory route and (11) reverting to some primitive social behaviour that led their shore-living ancestors to retreat to land when faced with a menacing sea (Keller Breland and F. G. Wood 1961, Ridgeway and Dailey 1972).

It is therefore necessary to record not only the species involved and data on strandings but also look for evidence which could reveal probable cause of strandings. It will be useful to record the shore line configuration in each instance and also to make a careful search for internal parasites, especially trematodes in the central nervous system, head sinuses and in the ears.

The present records of species in the region also reveal that some species such as *Mesoplodon ginkgodens* and *Eubalaena australis* are known from single records while several species have not been recorded after their early records more than fifty to seventy five years ago.

While accepting that the existence of several Cetacean species could only be known through strandings yet it should be the concern of

National Scientific Institutions in each country of the region to undertake a Cetacean faunal Survey off each country's coasts (and seas) and maintain up-to-date records of strandings with dates, of information on internal parasites, gut contents and the coastline configuration so that a clearer picture of both composition of species as well as of probable cause/s of strandings will become available.

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APPENDIX

Key to the identification of cetacean species from the region

1. Whalebone or baleen present 2
   Only calcified teeth present 8
2. With very long baleen plates. No throat furrows .... *Eubalaena australis*
   Shorter baleen plates and with throat furrows 3
3. Extremely long, often white pectoral fins, with knobs. Chins and jaws with tubercles .... *Megaptera novaeangliae*
   Much shorter pectoral fins, smooth. Chins and jaws without tubercles 4
4. Body length exceeding 60 feet 5
   Body length shorter 6
5. Both baleen plates and bristles black. Body mottled bluish gray and dark underneath .... *Balaenoptera musculus*
   Baleen plates on right side white, on anterior third. Remaining plates are bluish grey or blackish. Bristles white or yellow. Back of body dark. White underneath .... *Balaenoptera physalus*
6. Body length up to 30 feet. Baleen and bristles are uniformly yellowish white anteriorly, becoming gray to brown-black posteriorly .... *Balaenoptera acutorostrata*
   Body length between 30 and 60 feet. Baleen plates black or white anteriorly and black posteriorly 7
7. Throat furrows extend between pectoral fins and navel. Baleen bristles silky and curling. Tail flukes gray on both sides. Head without ridges anterior to blowhole ..... *Balaenoptera borealis*
   Throat furrows extend to the navel. Baleen bristles coarse, stiff and thick. Tail flukes gray above and white below. Three prominent ridges on head anterior to blowhole .... *Balaenoptera edeni*
8. Very long and narrow rostrum which is forceps-like 9
   Rostrum of variable length but never like above 10
9. Nasals with prominent crests. Teeth 30-36 in each tooth row .... *Platanista minor*
   Nasals with less prominent crests. Teeth 28-29 in each tooth row .... *Platanista gangeticus*
10. Skull with high occipital crest. Functional teeth on lower jaw only 11
    Skull without high occipital crest. Teeth in both upper and lower Jaws 14
11. Spermaceti organ present. Lower jaw with 8-30 teeth on each side 12
    Without spermaceti organ. Never more than 4 teeth on each side on lower jaw 13
12. Body length 30-65 feet. Head huge, box-like. With a dorsal hump two-thirds way back on body and behind it several low humps. .... *Physeter macrocephalus*
    Body length 7½ to 13 feet. Without box-like head. Dorsal fin erect and falcate, farther forward. No humps behind .... *Kogia simus*
13. With 2 conical teeth at tip of lower jaw .... *Ziphius cavirostris*
    With 2 laterally compressed, pointed teeth located near the middle of lower jaw .... *Mesoplodon ginkgodens*
14. No dorsal fin. Teeth spade-like, laterally compressed. .... *Neophocaena phocaenoides*
    With dorsal fin. Teeth generally conical 15
15. Mandibular symphysis greater than 30% of the length of ramus. Atlas and axis vertebrae are united, remainder free 16
    Mandibular symphysis less than 20% of length of ramus. Anterior 2 to 6 cervical vertebrae are united 17
16. Beak not separated from forehead by crease. Tooth surface roughened and furrowed. Body with yellowish white blotches. ....*Steno bredanensis*
    Beak separated from forehead by crease. Nearly smooth tooth surface. Body with dark elongated spots on the sides .... *Sousa chinensis*
17. Beak well defined sharply, set off from the forehead by crease 18
    Beak very short or absent 24
18. 19-26 large teeth on each side of upper and lower jaws. .... *Tursiops truncatus*
    30 or more small conical teeth on each side of both jaws 19
19. Palatal border of maxillae grooved. Teeth 40-65 in each tooth row on both upper and lower jaws 20
    Palatal border of maxillae ungrooved. Teeth 34-60 in each tooth row on both upper and lower jaws 22
20. Rostrum greatly elongate with 55-65 teeth in each side of both upper and lower jaws .... *Delphinus tropicalis*
    Rostrum shorter with less than 58 teeth in each side of both jaws 21
21. 54-58 teeth in each side of both jaws. With grey and yellow longitudinal bands on the

flanks .... *Delphinus capensis*
40-55 teeth in each side of both jaws. Without grey and yellow longitudinal bands on the flanks .... *Delphinus delphis*

22. Body usually spotted .... *Stenella attenuata*
Body unspotted 23

23. Beak shorter with 45-50 teeth in each tooth row. With black lateral stripes from eye to flipper and from eye to anus .... *Stenella coeruleoalba*
Beak longer with 45 to 65 teeth in each tooth row. Without black lateral stripes .... *Stenella longirostris*

24. With bulbous forehead 25
Forehead not bulbous 27

25. Teeth only on lower jaw ..... *Grampus griseus*
Teeth on both upper and lower jaws 26

26. Dorsal fin low with long base located in front half of back. 7-9 peg-like teeth in each tooth row. Body colour slaty-grey to black. Flippers tapering .... *Globicephala macrorhyncha*
Dorsal fin low, placed slightly behind middle of back. Teeth 12-19, in each tooth row, not peg-like. Flippers spatulate. Body colour uniform slaty-blue .... *Orcaella brevirostris*

27. Striking black and white colour pattern on body. Dorsal fin tall .... *Orcinus orca*
Body colour uniform black or dark grey to black, light grey underneath. Chin and lips often white 28

28. Body uniformly black. Flippers with distinct hump on leading edge of fin .... *Pseudorca crassidens*
Body black or dark grey, light grey underneath. Chins and lips often white. Flippers without hump 29

29. 21-25 teeth in each side of upper and lower jaws .... *Peponocephala electra*
8-13 teeth in each side of upper and lower jaws .... *Feresa attenuata*

ABBREVIATIONS USED

E.P. — Eastern Province of Sri Lanka

N.P. — Northern Province of Sri Lanka

N.W.P. — North Western Province of Sri Lanka

S.P. — Southern Province of Sri Lanka

W.P. — Western Province of Sri Lanka.

FISHES OF MUNDANTHURAI WILDLIFE SANCTUARY, TAMIL NADU[1]

A. J. T. JOHNSINGH[2] AND D. VIICKRAM[3]

(*With eight plates and a text-figure*)

Thirty three species of fishes belonging to 22 genera and nine families were collected and identified from Mundanthurai Wildlife Sanctuary, Tamil Nadu. Local names and note on their distribution in the sanctuary are given. Major conservation problems are identified and five suggestions for improving the potential of fishing resources in the sanctuary are given.

INTRODUCTION

One of the major objectives of the various Western Ghat development programmes should be to improve the fishing potential of local rivers and reservoirs (Gadgil 1984). Fishing potential in many parts of Western Ghats can be enhanced for sport fishing and local consumption as it is done with remarkable success by the Kerala Forest Department in Parambikulam Wildlife Sanctuary. In Tamil Nadu such a potential exists to a greater degree in Mundanthurai Wildlife Sanctuary and to a lesser extent in Mudumalai, Anamalai and in the Nilgiri tahr Sanctuary in Nilgiris. This photo-article on fishes collected from Mundanthurai is presented with the hope that this paper would help the Forest Department and the public at large in understanding and improving the potential of fishing resources of this enchanting sanctuary of rivers and reservoirs.

STUDY AREA

The Mundanthurai Wildlife Sanctuary (572 km^2, 8°30′ to 8°53′N latitude and 77°10′ to 77°29′E longitude) is situated in Ambasamudram taluk in Tirunelveli district, Tamil Nadu. This sanctuary can aptly be called the 'River sanctuary' of Tamil Nadu as many perennial streams and rivers such as Kil Manimuthar, Kandamparai, Tambiraparani, Pambar, Servalar, Kadananadhi and Ramanadhi flow through this Reserve. The perennial nature of these rivers is largely due to the presence of excellent rain forests in the catchment areas which experience both the South West and North East monsoons.

This sanctuary has three reservoirs, viz., Manimuthar, Upper Papanasam or Hope Lake and Lower Papanasam. Construction of one more reservoir, Servalar, started in 1974 is nearing completion now. The Manimuthar reservoir was built solely for irrigation and the other three for power generation.

The Fisheries Department was once regularly stocking the Upper and Lower Papanasam reservoirs with exotic carps. They have stopped this activity since 1980 when the Forest Department introduced 20, one meter long crocodiles in the Upper Papanasam reservoir. The Fisheries Department, however, continues to stock fish in Manimuthar reservoir. Four to ten fishermen licensed by the Fisheries Department periodically fish in the Upper and Lower Papanasam reservoirs and in Tambiraparani and Servalar rivers using gill nets.

The rivers originate in different parts of the Sanctuary (Fig. 1). The Kil Manimuthar and

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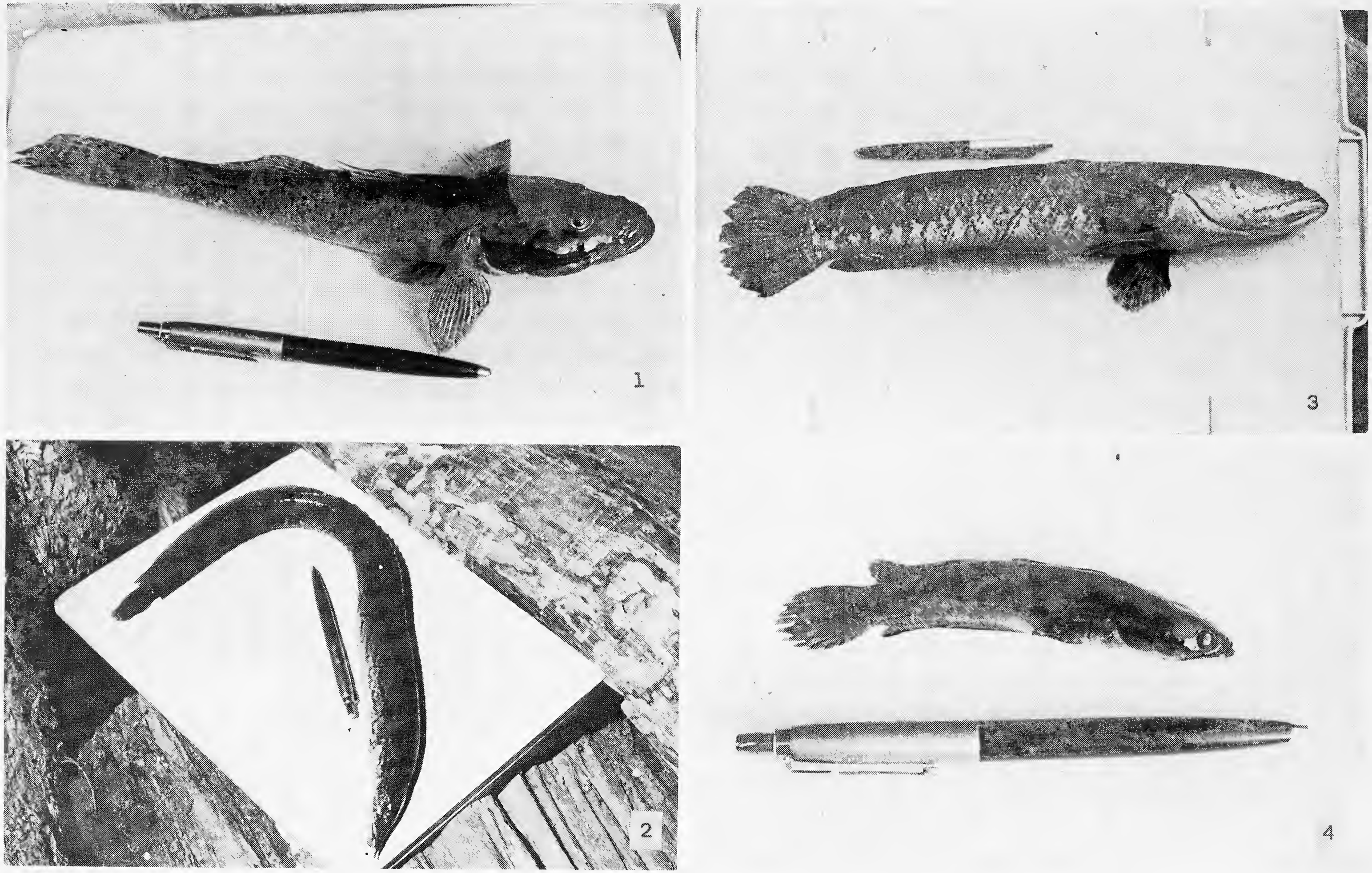
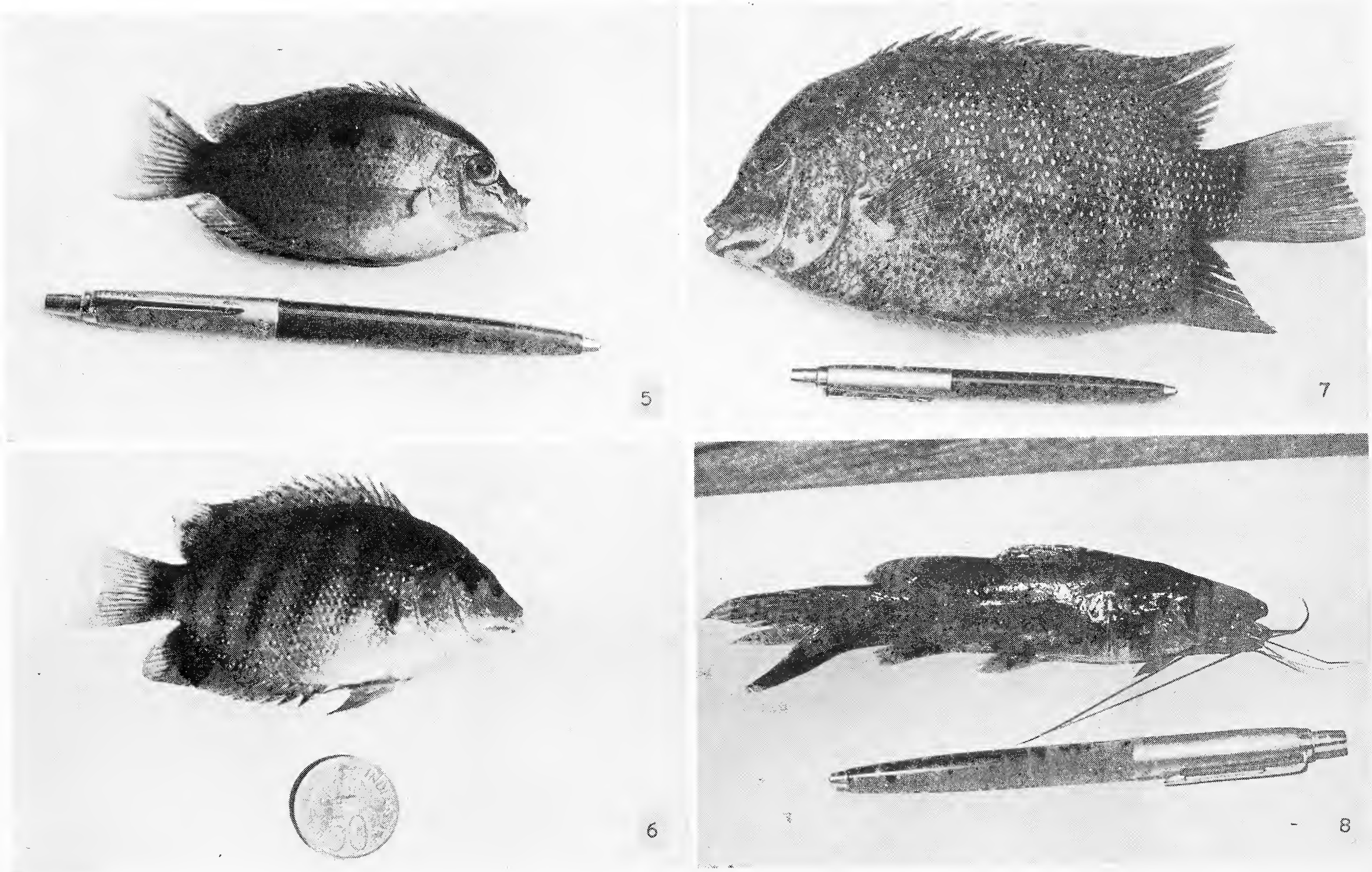
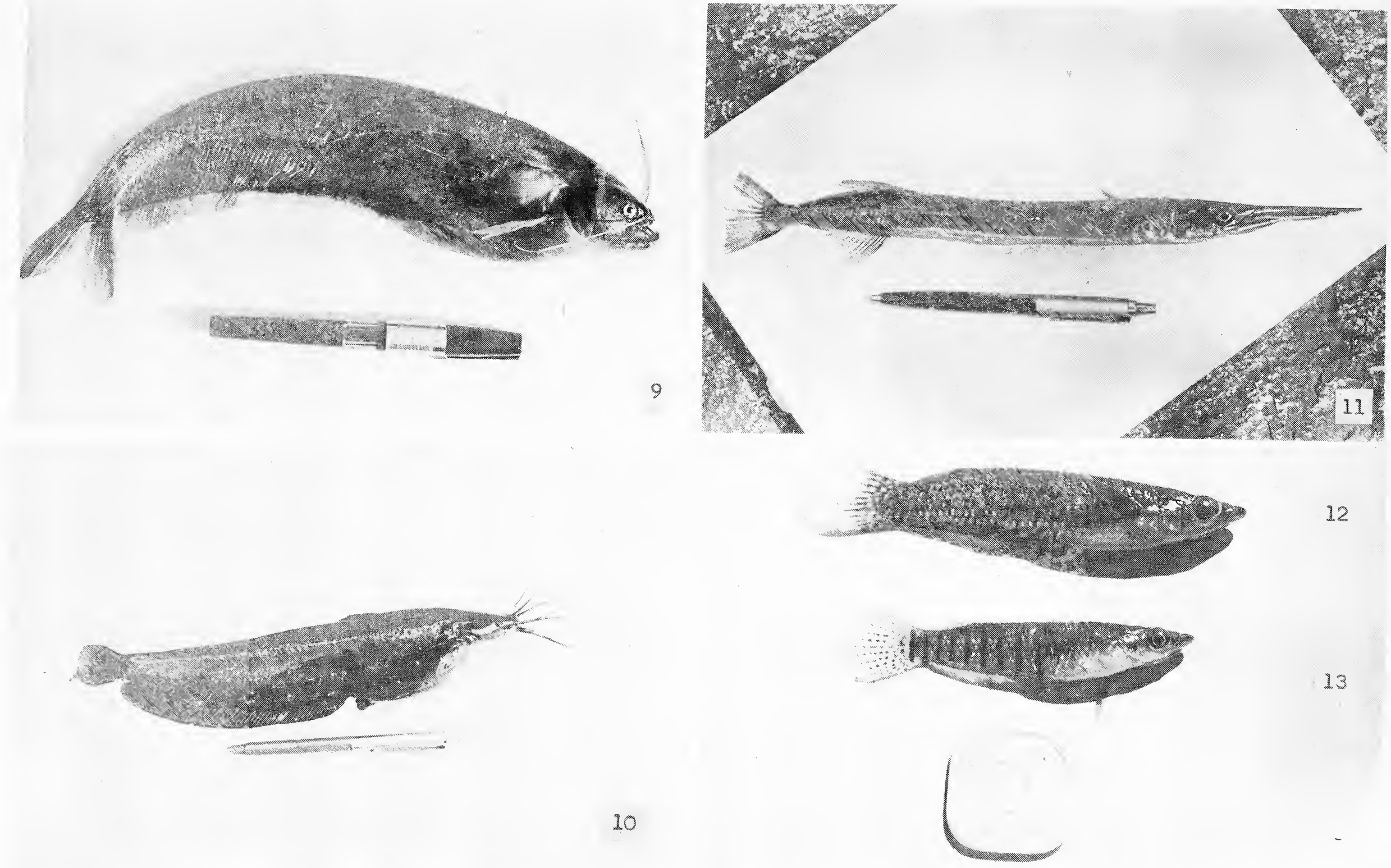
PLATE I



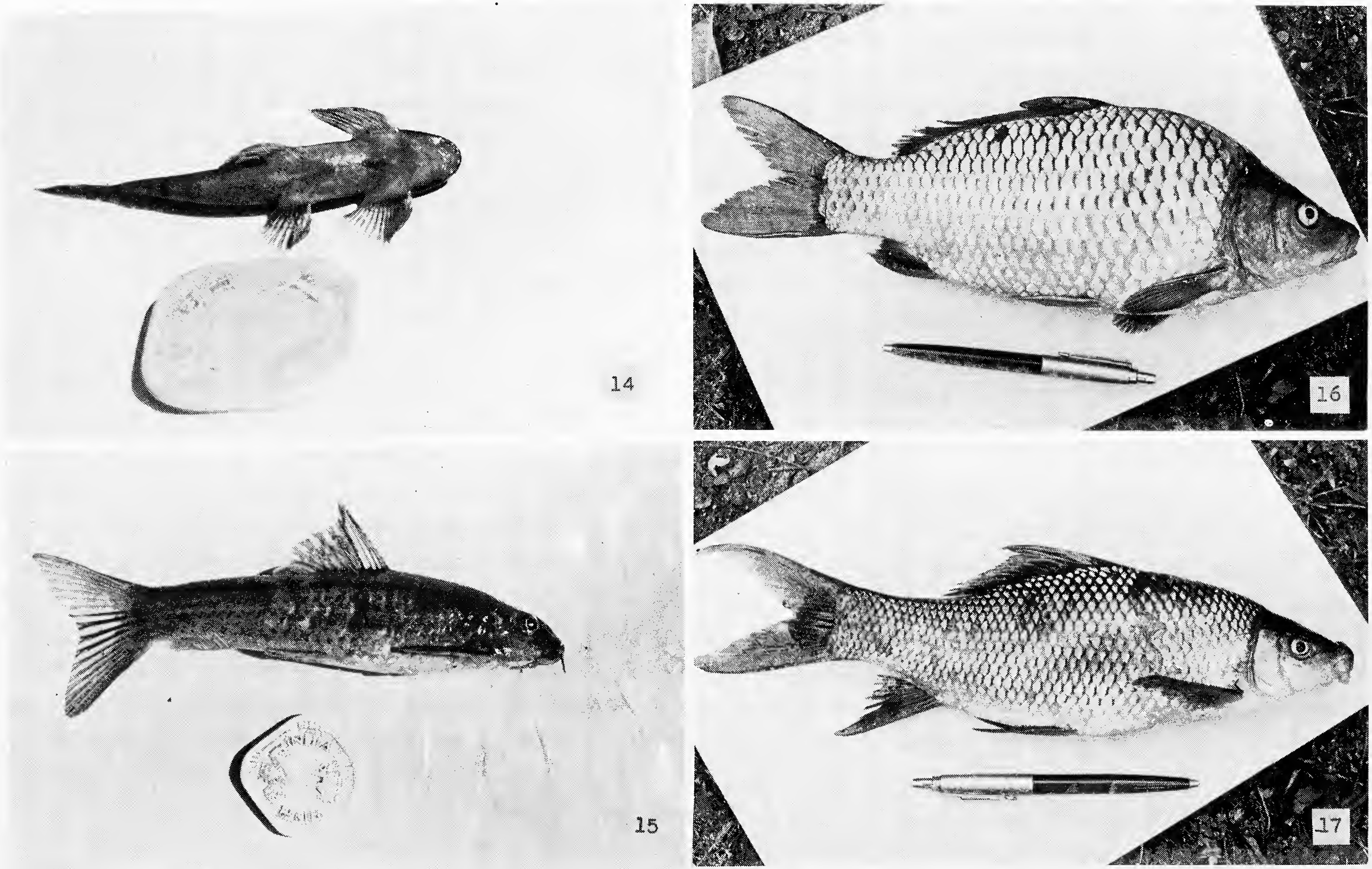
1. *Glossogobius giuris*; 2. *Mastacembelus armatus*; 3. *Channa striatus*; 4. *Channa gachua*.



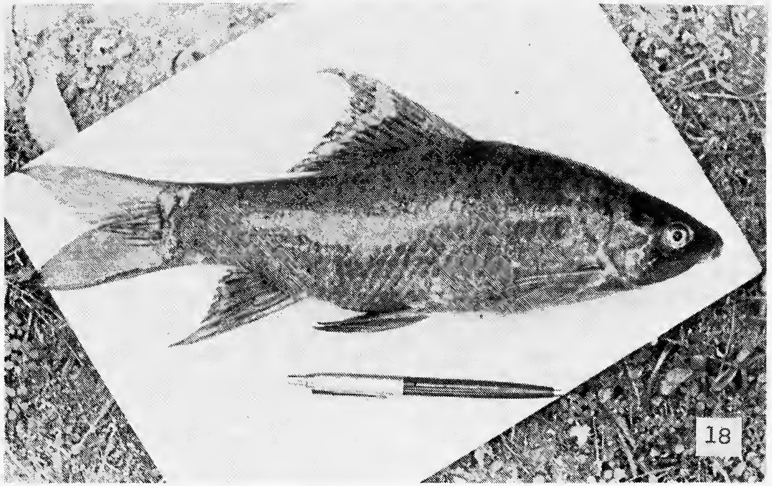
5. *Etroplus maculatus*; 6. *Etroplus suratensis*; 7. *Tilapia mossambica*; 8. *Macrones vittatus*.



9. *Callichrous bimaculatus*; 10. *Saccobranchus fossilis*; 11. *Belone cancila*; 12. *Haplochilus rubrostigma*; 13. *Haplochilus lineatus*.



14. *Homaloptera brucei*; 15. *Discognathus modestus*; 16. *Cyprinus carpio communis*; 17. *Labeo fimbriatus*.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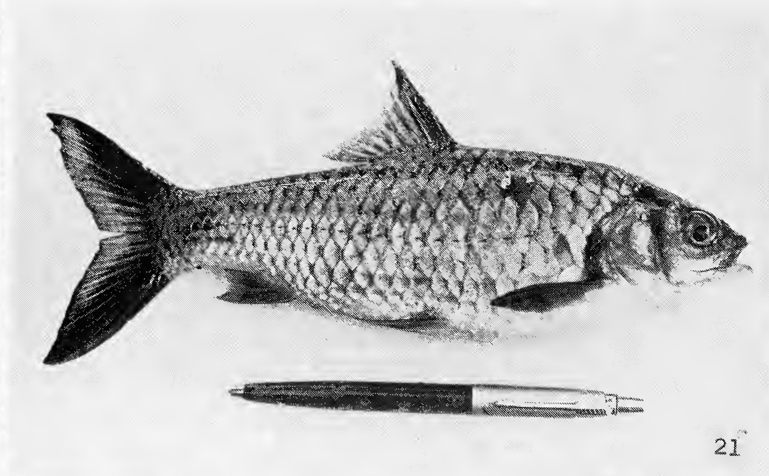
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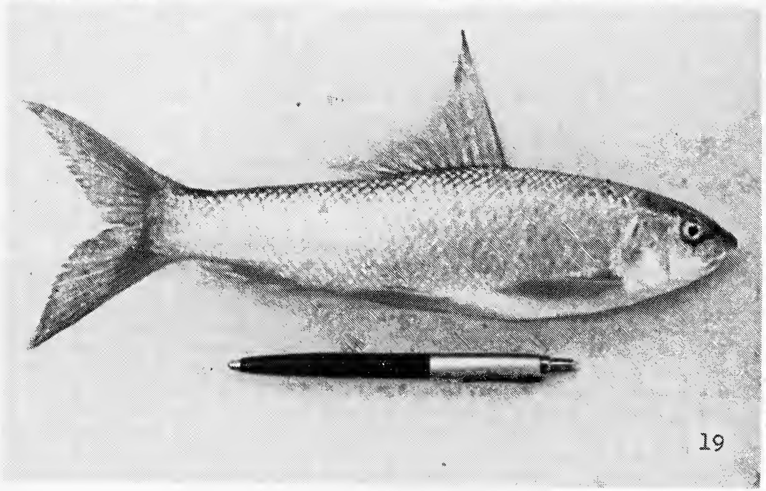
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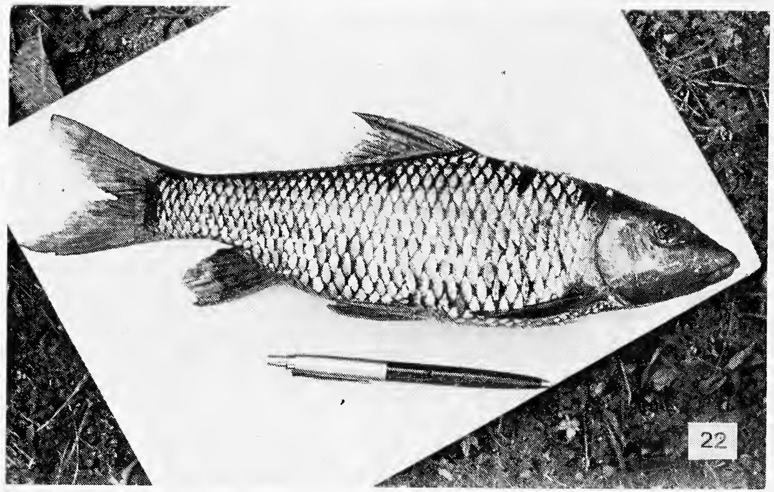
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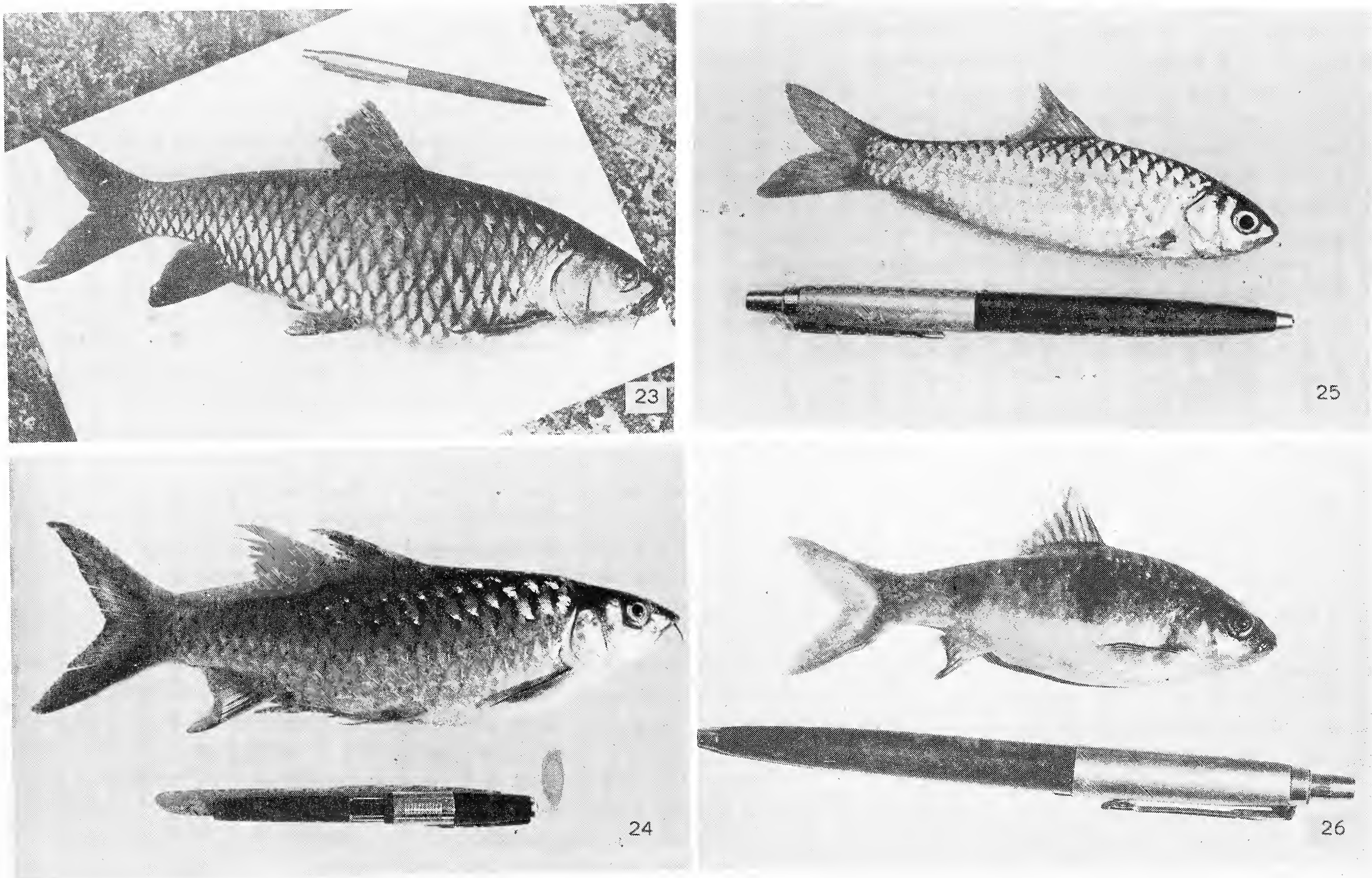
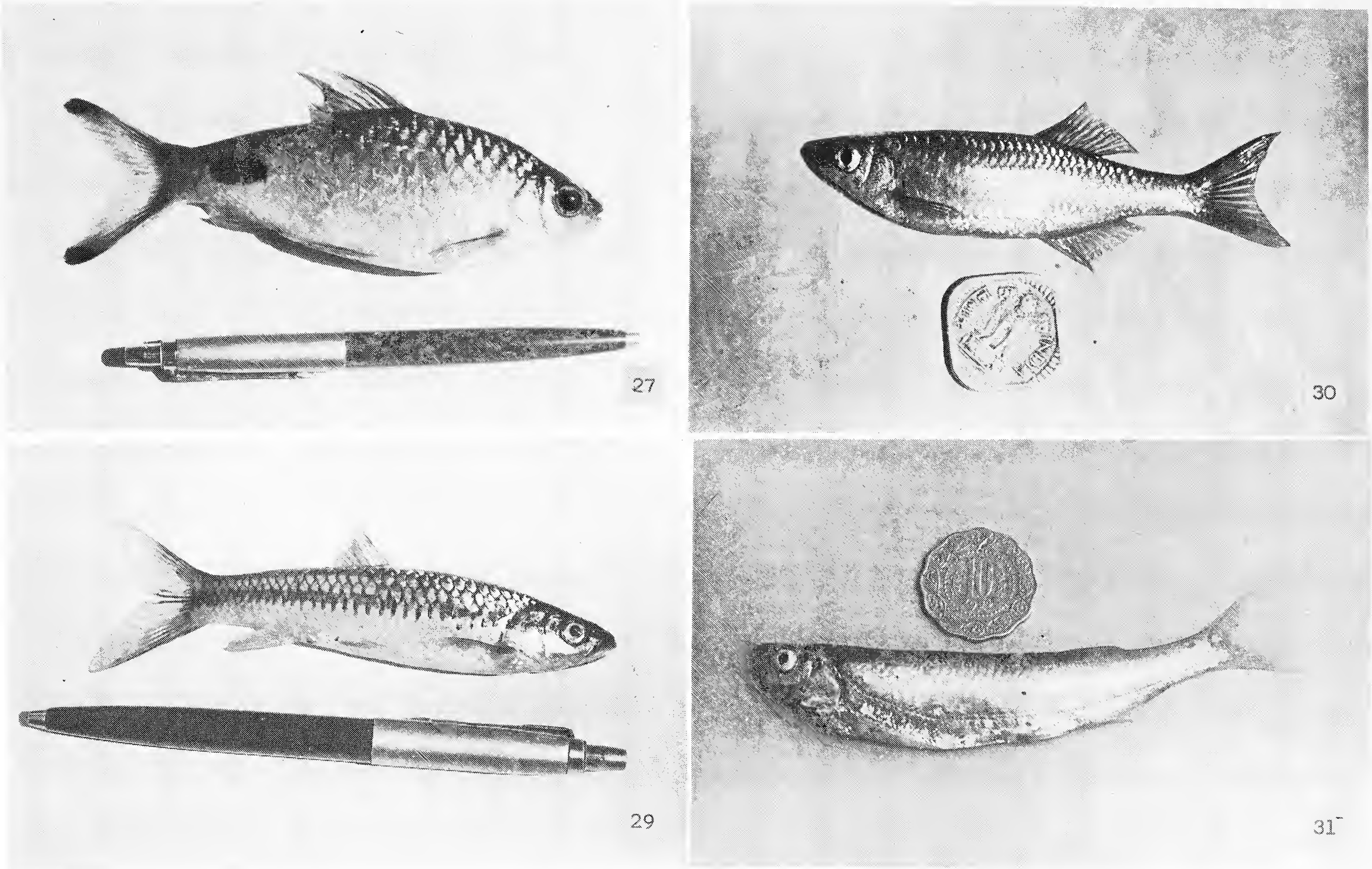
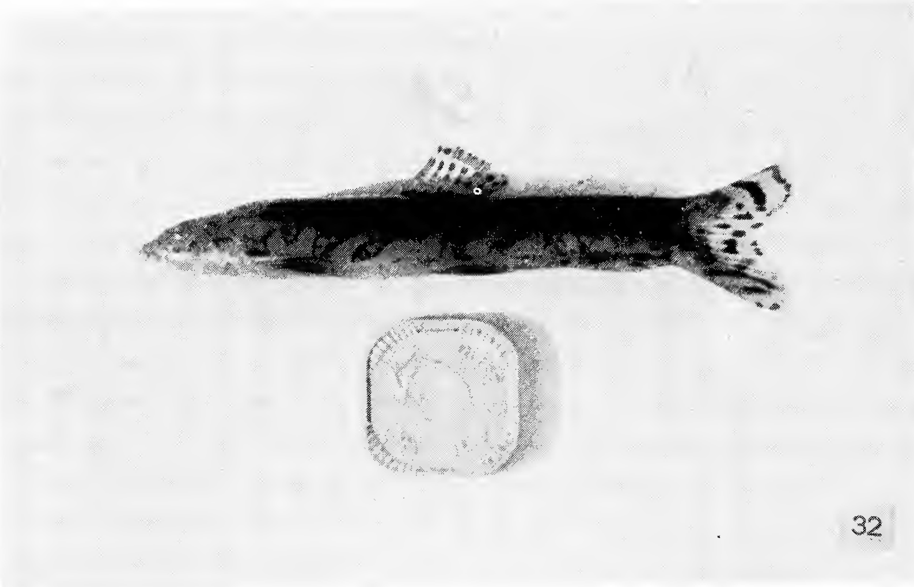
18. *Labeo calbasu*; 19. *Cirrhina mrigala*; 21. *Barbus savana*; 22. *Barbus dubius*.

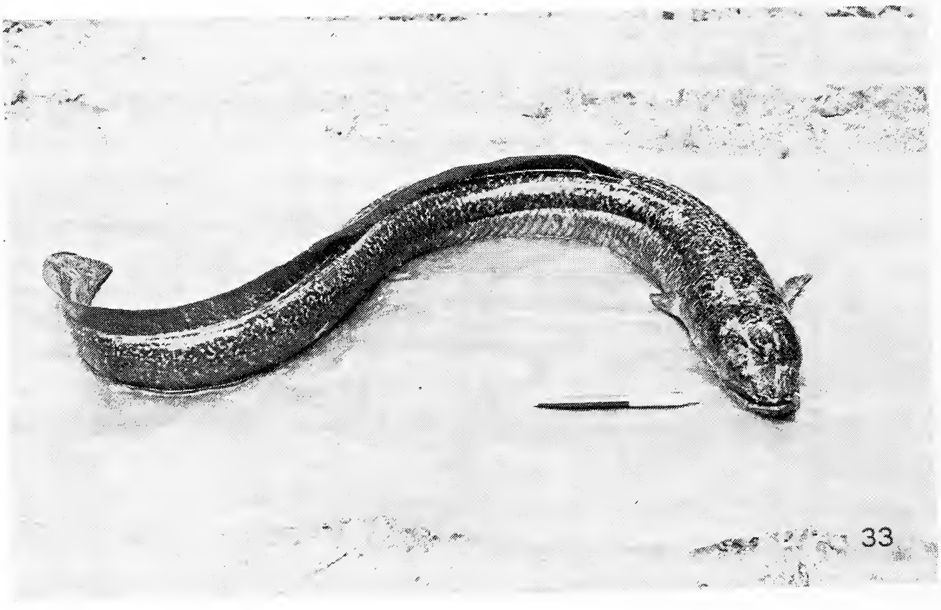


23. *Barbus carnaticus*; 24. *Barbus malabaricus*; 25. *Barbus amphibius*; 26. *Barbus arulius*.



27. *Barbus mahecola*; 29. *Rasbora daniconius*; 30. *Danio aequipinnatus*; 31. *Chela untrahi*.





32. *Nemacheilus pulchellus*; 33. *Anguilla bengalensis*.

Kandamparai rivers, infact, arise in the adjacent Kalakadu Wildlife Sanctuary and empty into Manimuthar reservoir. The Tambiraparani river springs from Agastyar malai (malai = mountain, 6132′) flows through Injikuzhi valley, forms many rapids and falls before ending in Upper Papanasam reservoir. The last falls of this river, Bhanatheertham, is magnificent. The Servalar river drains the deep, densely wooded Valayar valley and joins the

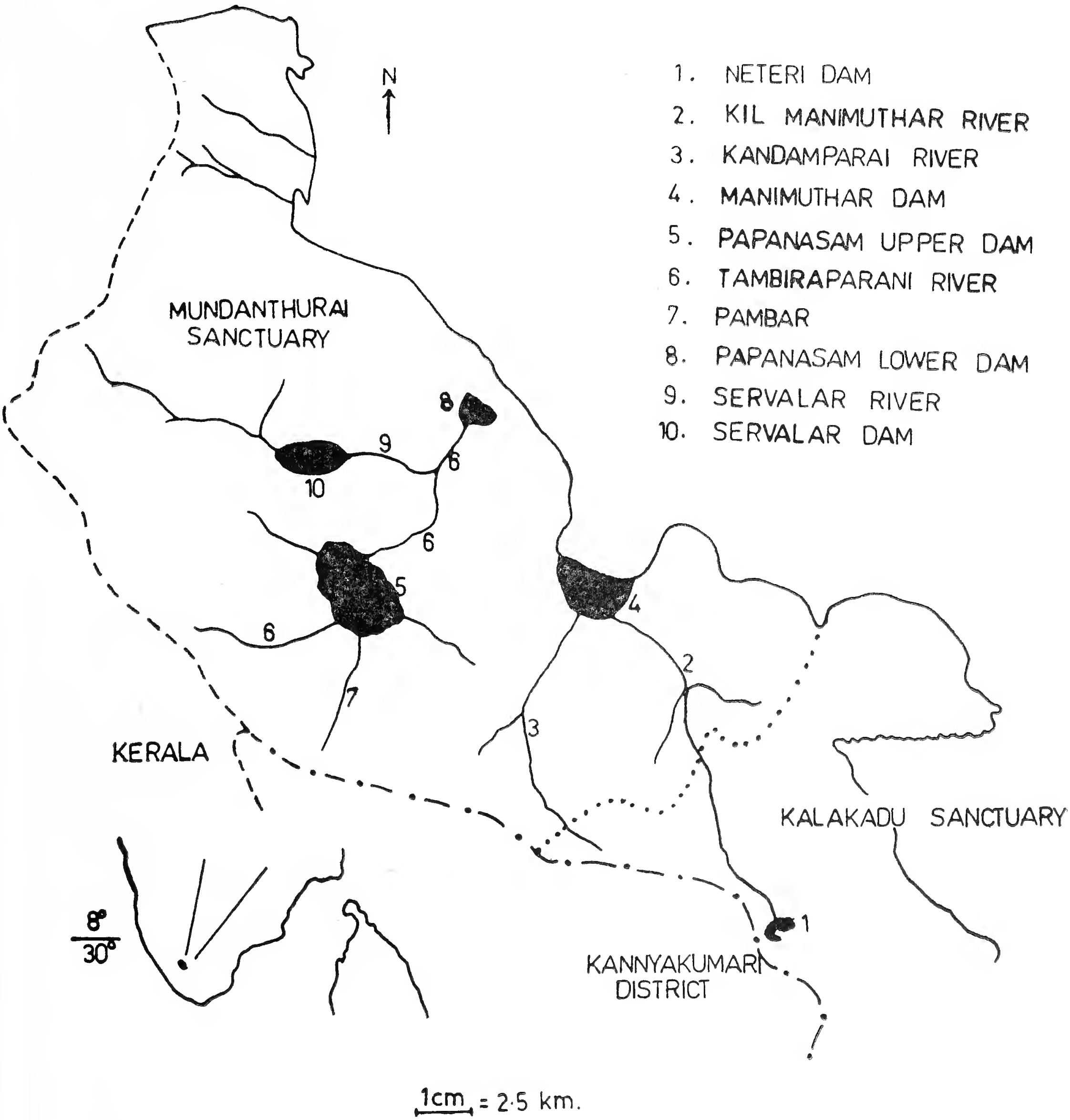


Fig. 1. Rivers and reservoirs mentioned in the text.

river Tambiraparani one kilometer from the Lower Papanasam reservoir. Our collections were done in these rivers and reservoirs.

Methods

Fishes were collected in three ways. Some were caught with hooks baited with worms, grass hoppers and small fishes. In some instances a long towel was used to dredge the fish out of water. The rest were obtained from the local fisherman. Fishes were photographed, preserved in five percent formalin and identified with the assistance of experts.

Results

Thirty three species of fishes representing 22 genera and nine families were collected and identified. As morphological particulars of these species are already available (Chandy 1970, Day 1981, Munro 1982 and Jayaram 1981) we present only brief notes on their status and distribution in the study area (Table 1).

Conservation problems and suggestions for improvement

Kanis (local tribals) above 60 years of age speak of abundant fish in all the rivers especially in Kandamparai, Pambar, Tambiraparani and Servalar below Kooduparai. According to them this abundance once even supported '*Cheenganni*' (*Crocodilus palustris*?) in Tambiraparani and Servalar rivers. Thomas (1984) even speaks of mahseer which was caught in Tambiraparani river hundred years ago. Apparently fishes in these rivers started to disappear with the arrival of large number of workers for the construction of the Upper and Lower Papanasam dams who had an easy access to dynamite. The prolonged construction period of the Servalar dam has worsened this situation. The worst affected rivers are Pambar, Tambiraparani and Servalar.

Two potent fish poison plants occur in Mundanthurai hills. *Milletia racemosa* is a native climber commonly seen along river banks in moist and evergreen areas. The other is *Tephrosia candida,* an exotic, cultivated for green manure, wind brakes, shade and for nursing and mulching in the tea plantations around Manjolai estate which is situated within the sanctuary limits. Estate workers and Electricity Department staff who go to record rainfall data from Injikuzhi frequently use these piscicide plants to indiscriminately kill fish populations in Tambiraparani river above Bhanatheertham falls and in Kadamparai river. Ultimate sufferers of this nefarious activity are the Kanis who depend on the fishes of these rivers for their badly needed protein.

As mentioned earlier four to ten persons periodically use gill nets with five centimetre meshes which are much smaller than the prescribed size of ten centimetres. This coupled with the use of dynamite and pisicides have decimated much of the fish populations in the rivers and reservoirs.

Fortunately the situation is not beyond recovery as we still have the rivers and reservoirs with enough fish which can bloom into a healthy population within five years if there is *strict protection* and *little restocking.* We earnestly hope that the following suggestions would be implemented by the Tamil Nadu Forest Department *immediately* so as to improve the status of the fishes in the sanctuary.

1. All types of fishing activities, excluding fishing with hooks, which are largely done by the locals, should be stopped at least for the next five years in rivers and reservoirs except Manimuthar reservoir.
2. Right to fish in the rivers and reservoirs other than Manimuthar reservoir should be under the direct control of the Forest Department who should control dynamiting and mis-

TABLE 1

DETAILS OF THE FISHES COLLECTED FROM MUNDANTHURAI WILDLIFE SANCTUARY

Sl. No.	Order, Family and Species name	Local name	Range of the species	Distribution in the study area	Notes
(1)	(2)	(3)	(4)	(5)	(6)
	ORDER: ACANTHOPTERYGII Family: GOBIIDAE				
1.	*Glossogobius giuris*	Uzhuvai	East coast of Africa, in all fresh water habitats throughout India, Sri Lanka, Burma, Sind to the Malay Archipelago.	In all the rivers and dams except in higher altitudes.	Prefers sandy beds.
2.	Family RHYNCHOBDELLIDAE *Mastacembelus armatus*	Aaral	Extends from Sind throughout the fresh and brackish waters of India, Sri Lanka and Burma to China.	River Servalar and Tambiraparani and Papanasam Upper and Lower dams.	Often found close to rocks and in submerged net work of roots.
3.	Family: OPHIOCEPHALIDAE *Channa striatus*	Viral	Throughout the fresh water habitats of India, Sri Lanka, Burma to China and Philippines. Common in swamps and grassy tanks.	Once seen in Manimuthar dam.	Could be introduced in Lower Papanasam dam which has grassy edges.
4.	*Channa gachua*	Pothi, Kuravai	In fresh water habitats throughout India, Sri Lanka, Burma and Andamans.	In all the rivers and dams except in higher altitudes.	—
5.	Family CHROMIDES *Etroplus maculatus*	Challai	In fresh water habitats along the coast of Madras and from South Canara along Malabar and in Sri Lanka.	Seen in lower altitudes in river Servalar and Tambiraparani and in Papanasam Lower and Upper dam.	—
6.	*Etroplus suratensis*	Panrichethai	In fresh and brackish waters along the coasts of Sri Lanka, India as far as Orissa, Tranqubar and Wyanad.	—do—	—
7.	*Tilapia mossambica*	Jilapi kendai	Native of Africa.	Well established in upper and lower Papanasam dams and in Manimuthar dam.	Introduced by Fisheries Department.

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
	ORDER: PHYSOSTOMI Family: SILURIDAE				
8.	*Macrones vittatus*	Keluru	Throughout Sind, the continent of India, Assam, Burma Siam and Sri Lanka.	—do—	—
9.	*Callichrous bimaculatus*	Chotta valai, Aathu valai	In the fresh waters of Sind, from Punjab throughout India, Sri Lanka, Assam to Malay Archipelago and beyond.	—do—	—
10.	*Saccobranchus fossilis*	Theli	In fresh waters of Sind, India, Sri Lanka and Burma.	Said to occur in Manimuthar, Upper and Lower Papanasam dams.	Rare
11.	Family: SCOMBRESOCIDAE *Belone cancila*	Koku meen	In fresh waters of Sind, India and Sri Lanka and also throughout Burma.	Seen in Servalar and Tambiraparani rivers and in Manimuthar, upper and lower Papanasam dams.	Often seen in pairs.
12.	Family: CYPRINODONTIDAE *Haplochilus rubrostigma*	Vanampathakanni	Occurs in fresh water habitats of Malabar coast and lower portions of Coromandal Coast of India.	Were commonly seen in rain water puddles along river Servalar and Tambiraparani, Manimuthar, Upper and Lower Papanasam dams.	This 7-8 cm long fish can be easily identified by the presence of a bright luminous spot on the top of the head.
13.	*Haplochilus lineatus*	—do—	Found in Coorg and Wyanad down to Malabar Coast and Sri Lanka.	—do—	Has the bright luminous spot but differs from *H. rubrostigma* in having eight black vertical bands on the sides of the body.
14.	Family: CYPRINIDAE *Homaloptera brucei*	Parai otti	This genus is found in India, Burma, Thailand, Indo-China, Malay Peninsula, Sumatra, Java and Borneo. In India this species is found in Wyanad, Bhavani river in Tamil Nadu, in Himalayas from about Darjeeling through Bhutan, Assam and the Kasi hills.	Seen in upper reaches in swift flowing sections of Tambiraparani, Pambar and Valayar.	Seems to be adapted to the high oxygen content of the torrents.

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
15.	*Discognathus modestus*	Kallari	North India	Seen in upper reaches in all the rivers.	Mouth has an adhesive sucker which aids in moving along the rocks aven against the flow of torrential streams.
16.	*Cyprinus carpio communis*	Bangostine	China and South East Asia	Manimuthar dam, Papanasam upper and lower dams.	Introduced by Fisheries Department.
17.	*Labeo fimbriatus*	Sale kendai	Found in Sind, Punjab, probably in North East Bengal and in Deccan atleast upto Orissa.	Occurs in the river Tambiraparani and Servalar, in Manimuthar and Papanasam upper and lower dams.	—do—
18.	*Labeo calbasu*	Kalpasu, Sheela	Occurs in Sind, Punjab, Deccan upto Orissa, Bengal and Burma.	—do—	—do—
19.	*Cirrhina mrigala*	Mrigala	Occurs in Sind, Punjab, Cutch, Deccan, Bengal and Burma.	—do—	—do—
20.	*Catla catla*	Catla	Occurs in Sind, Punjab, the Deccan, throughout Bengal, Assam and Burma as far as the Pegu river.	—do—	—do—
21.	*Barbus savana*	Panjalai kendai	Sind, Punjab, throughout India and Burma.	—do—	—do—
22.	*Barbus dubius*	Koodal	Bhavani river and in Nilgiris	Occurs in the river Tambiraparani and Servalar; in Manimuthar and Papanasam upper and lower dams.	—
23.	*Barbus carnaticus*	Kalathi kendai	Nilgiris, Wyanad and South Canara hills	—do—	This fish has been successfully introduced by *Kanis* in Tambiraparani river above Bhanatheertham water falls.
24.	*Barbus malabaricus*	Perumpirani kendai	From South Canara down all along western ghats	—do—	—do—

TABLE 1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)
25.	*Barbus amphibius*	Pachilai vetti	South of Central India	—do—	—
26.	*Barbus arulius*	Muthukutan, we have named it as Tiger fish	Wyanad, Nilgiris and down south	Commonly occurs above Bhanatheertham and in Kil Manimuthar and Kandamparai river.	Can be used as an aquarium fish.
27.	*Barbus mahecola*	Sothu kendai	From North Canara down south all along western ghats and in Sri Lanka	In river Tambiraparani below Bhanatheertham, Servalar and in Papanasam upper and lower dams.	—
28.	*Barbus stigma*	Panjalai kendai	Sind, throughout India and in Burma	Said to occur in Manimuthar dam.	—
29.	*Rasbora daniconius*	Kolathu kendai	Throughout India, Sri Lanka, Burma, Malay Archipelago and Zanzibar	In river Tambiraparani below Bhanatheertham, Servalar and in Papanasam upper and lower dams.	—
30.	*Danio aequipinnatus*	Ramar kendai	Himalayas from Darjeeling to Garo hills and in Deccan.	Common in Tambiraparani above Bhanatheertham and in Kil Manimuthar river.	—
31.	*Chela untrahi*	Vellichi	Mahanadi in Orissa, Cauvery and Coleroon in Tamil Nadu	Said to occur in Papanasam upper dam.	Rare
32.	*Nemacheilus pulchellus*	Ayerai	Bhavani river	Common in Tambiraparani and Servalar rivers, and in Upper and Lower Papanasam dams.	—
33.	Family: MURAENIDAE *Anguilla bengalensis*	Velangu meen	India, Burma and on the Islands in the Indian Ocean.	Occurs in all the dams and in deep pools in all the rivers even in upper reaches.	Much relished by the local people and needs restocking.

use of gill nets. If necessary two or three present licence holders using gill nets can be appointed as fish guards.

3. Servalar reservoir and Neteri dam in Kalakadu should be stocked with *Barbus carnaticus* and *B. malabaricus. Barbus carnaticus* as it takes spoons and flies will eventually attract anglers to this sanctuary. Both these fishes are native to this area, easily grow to five Kilograms and therefore need special attention. If Neteri dam is stocked eventually the fishes can populate Kil Manimuthar river which at present has no larger fishes but has many excellent long and deep pools.

4. Mahseer could be introduced in Neteri dam and should be reintroduced in Tambiraparani in Injikuzhi valley and in Servalar reservoir.

5. Periodically the rivers and reservoirs should be restocked with the young of the eel (*Anguilla bengalensis*). Eel is much relished by the local people and frequently caught.

ACKNOWLEDGEMENTS

We thank the Tamil Nadu Forest Department for having permitted us to work in Mundanthurai. One of us (AJTJ) was able to take part in this study when he was surveying elephant habitat in Mundanthurai and Kalakadu Wildlife Sanctuaries supported by the Endangered Species Project of the Bombay Natural History Society which was financed by U. S. Fish and Wildlife Service (U.S. Dept. of the Interior Grant No. 14-16-0009-84-959) and sponsored by Dept. of Environment, Govt. of India. Their assistance is gratefully acknowledged.

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MONKEYS OF JAIPUR, RAJASTHAN, INDIA: (*MACACA MULATTA, PRESBYTIS ENTELLUS*)[1]

LINDA D. WOLFE[2] AND REENA MATHUR[3]

(*With three text-figures*)

This brief report presents information on the continuing presence of rhesus (*Macaca mulatta*) and langur (*Presbytis entellus*) monkeys in the city of Jaipur, India, and documents the occurrence of the lobster claw deformity in a 2 year old rhesus female.

INTRODUCTION

The purpose of this research was to census the rhesus and langur monkeys of Jaipur, India, in order to contribute to attempts to estimate the number of monkeys remaining in India. Jaipur was chosen because preliminary observations by one of the authors (RM) indicated that there were a large number of rhesus and langur monkeys in and around the city which have not previously been censused. In general, *Macaca mulatta* is found in the old part of Jaipur and *Presbytis entellus* is located on the outskirts of Jaipur. It should also be noted, however, that Jaipur is an excellent locale to study the interaction between the two cercopithecoid species as they co-exist in two places: at Galta (a hillock outside Jaipur) and within Jaipur near Govindevji Temple.

MATERIALS AND METHODS

Jaipur is located 258 km south of Delhi (26°50′N, 75°55′E) and has a semi-arid climate. Jaipur can be divided into 2 sections: A. the old walled city and B. a modern suburb which surrounds the walled city (see figure 1). The walled city can be further divided into 2 parts: 1. a congested business district and 2. a more open tourist area which includes a temple dedicated to Krishna.

Macaca mulatta

The monkeys of Jaipur are most visible in the early morning and late afternoon hours. Each morning and afternoon of the census, the areas that rhesus monkeys were known to frequent were walked. When monkeys were encountered they were observed, counted and the data recorded. Attempts were made to individually identify as many of the monkeys in each troop as possible so that the number of troops could be estimated. Whenever langurs were observed during the censusing of the rhesus, the presence of langurs was also noted. The census was carried out between September 16 and December 14, 1984, for a total of 70 contact hours. The existence of rhesus monkeys located in other areas around Jaipur such as Gator, Sisodia Ranika Mahal or Amber Fort (see Figure 2) was not investigated.

Presbytis entellus

Information on the langur population of Jaipur and the surrounding areas was obtained (by RM) by 1. making enquires of local inhabitants, 2. travelling the roads by scooter looking for langurs and 3. remaining in one place for observations. The open scrub and moderate tree vegetation around Jaipur pro-

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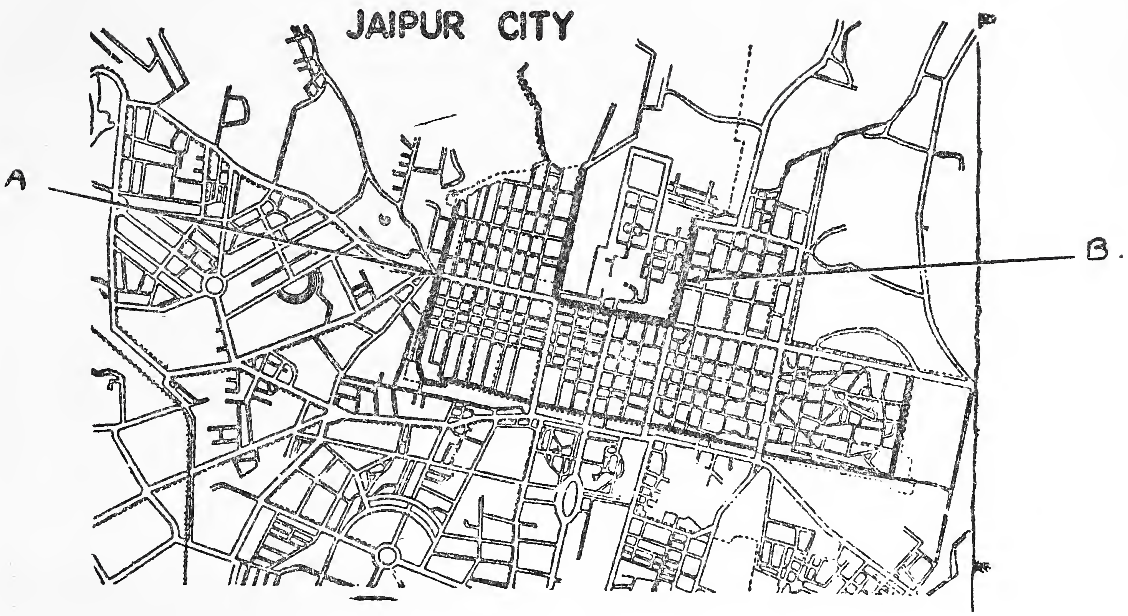

Fig. 1. City of Jaipur.
A. Walled part of Jaipur. B. City Palace area.

vides excellent opportunities for observations. These observations on the langurs have been carried out over the last 2 years.

Results and Discussion

Macaca mulatta

The rhesus monkeys inhabit the old part of Jaipur within a rectangular area of approximately 3 km by 2 km. There are also rhesus monkeys at Galta, a hillock with temples and a spring which is located 1 Km from Jaipur's Surajpole Gate (8 km by road, see Figure 2).

The monkeys that inhabit the city of Jaipur can be divided into 2 groups—1. those that live in the tourist area (hereafter called the City Palace area) which contains the City Palace, Jantar Mantar (Observatory) and Govindevji Temple and 2. those that live in the city itself outside of the City Palace area. In general, the monkeys which inhabit the City Palace area seem to have easier access

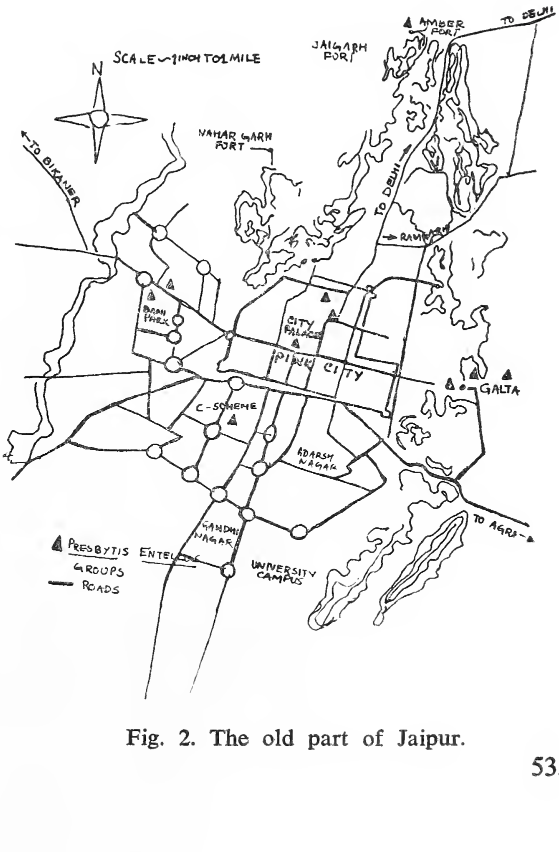

Fig. 2. The old part of Jaipur.

to food than the monkeys outside of the City Palace. Within the City Palace area there are fig trees (*Ficus bengalensis*) and imli trees (*Tamarindus indica*) and three grassy areas where the monkeys forage for grass and insects. These areas are located 1. adjacent to the temple, 2. within the fence which encloses the Jantar Mantar and 3. near a City Palace gate known as the Atish Bazaar. Moreover, the monkeys in the City Palace area are fed frequently — especially on Tuesdays and Saturdays, the special days associated with the monkey god Hanuman — by visitors to the City Palace area in about the same places as are located the grassy areas. Our observations suggest that obtaining sufficient amounts of water may represent more of a challenge than finding sufficient food. Substantial rainfall occurs only during the months of July, August and September. Even during those months, the average monthly accumulation is under 200 mm. The monkeys of the City Palace area obtain water from artificial cement pools which are located in the grassy areas and on the roof tops of the public buildings that are located within the City Palace area. The water on roof tops is also stored there for various purposes.

The monkeys which live outside the City Palace area do not have a grassy area in which to forage and they are less frequently provided food by people. The monkeys of the city seem to subsist on day old chapatis (thin Indian bread made from whole wheat flour) given them by the inhabitants of the city and on the food they steal from food vendors who sell their fruits and vegetables on the sidewalks. The monkeys of the City Palace area did, in fact, appear to be in better health than the monkeys outside of the City Palace. The monkeys of the city also face the hazard of being electrocuted from electrical wires located on roof tops. Two incidents of rhesus monkeys dying from electrocution were reported to me by local residents during the time period of the census.

The rhesus seem to have relatively small core areas where they spend most of their time. The location and size of troops are outlined in Table 1. Monkeys of all ages were observed.

One limb deformity (see Figure 3) was noted in the rhesus troop identified as Atish Bazar 1 (Table 1). According to the limb deformity identification scheme of Homma (1980), the deformity in this Jaipur rhesus seemed to be a 2-digit cleft deformity with digits II, III and IV missing. The deformity

Fig. 3. Lobster Claw deformity in a juvenile Rhesus Macaque of Atish.

TABLE 1

LOCATION AND SIZE OF THE RHESUS TROOPS OF JAIPUR AND GALTA

City Palace Area	Number of Monkeys
Govindevji Temple area	70
Jantar Mantar	55
Atish Bazaar 1	40
Atish Bazaar 2	25
Groups Located Outside of the City Palace	
Chaura Rasta	20
LMB Hotel area	40
Ramganj Bazaar	25
Johari Bazaar?	25
Galta	150
Total Population of Jaipur and Galta	450
Amber Fort Area (10 Km from Jaipur)	
Amber (Seth, Seth and Shukla 1983)	25 Monkeys

was present on all 4 limbs. No limb deformities were noted in any other troops. The monkeys of the Atish Bazaar drink the water which flows into the streets from small iron and paint manufacturing shops which exist around the bazaar. We speculate, therefore, that the limb deformity is the result of teratogenic agents in the drinking water of the monkeys.

Presbytis entellus

Approximately 30 groups of langurs in and around Jaipur have been identified through verbal enquires and road surveys. However, ten groups have been observed more intensively and the results of those observations are presented in Table 2. There are 388 individuals found in the 10 groups with a group size average of 38.8. Three types of Langur

TABLE 2

LOCATION AND SIZE OF THE LANGUR GROUPS OF JAIPUR AND GALTA

City Palace Area	Number of Monkeys	
Jantar Mantar	28	Unimale Group
Govindevji Temple area	37	Resident Unimale Group
Govindevji Temple area	49	Transient Multimale Group
Jaipur Suburb Groups		
Bani Park A	30	Unimale Group
Bani Park B	13	All Male Group
C-Scheme	27	Unimale Group
Galta		
Galta A	50	Unimale Group
Galta B	54	Unimale Group
Galta C	60	Multimale Group
Amber Fort Area (10 Km from Jaipur)		
Amber	40	Unimale Group
Total	388	

groups have been observed: 1. unimale group, 2. multimale groups and 3. all male groups. Both unimale and multimale groups were observed within the City Palace area near the Govindevji Temple and Jantar Mantar. While occasional solitary langurs were observed within the city of Jaipur, there are no groups which seemed to live in the old walled city in the manner of the rhesus. Rather, the langurs mainly inhabit the suburbs.

Mating Season

The mating season of the rhesus monkeys begins in mid-October. Prakash (1962) reported that the rhesus of Jaipur had 2 birth seasons — one in March, April and May and another in September and October. During our observations, there were no infants born in September or October. All infants appeared to be about 6 months old during our census.

The langurs, on the other hand, seem to lack a distinct breeding and birth season. Neonates were observed in each month of the census. Older Infants and juveniles appeared to have been of ages which would suggest that births occur throughout the year.

Galta

The situation at Galta was different than the one in Jaipur in that the monkeys of Galta inhabit an area which except for the entrance from Jaipur lacks a residential area. The area is a subarid zone with a natural spring at the top of the hillock and a creek which flows down the hill on the opposite side from Jaipur. While people bring food to feed the monkeys of Galta, they appear to do so less than what we had observed in the City Palace area. However, people were observed buying gram seed and peanuts from local vendors to feed the monkeys. The priests associated with the temples at Galta also fed the monkeys small amounts of plant food. Much of the food of the monkeys was natural food for which the monkeys foraged. Monkeys were observed foraging on the grasses and in the trees which grow near the creek and shifting through the sand and apparently finding something to eat perhaps insects in the sand. The trees of Galta are sparse and typically dry deciduous. Unfortunately, it was not possible to ascertain where the monkeys slept.

There were 5 groups of rhesus at Galta, 1. on the hill just outside Jaipur near Surajpole Gate, 2. on the top of the hill where the temples are located, 3. at the bottom of the hill where the food vendors are located, 4. at the entrance to the temple area from the road and 5. just outside the roadside entrance. The largest group was the one located on the hillside near Surajpole Gate. The relationship between the 5 groups is unknown. Prakash (1962) also reported the existence of 5 groups of rhesus at Galta.

Langurs (Table 2) were observed living near the Surajpole Gate entrance to the Galta hillock. This group overlaps with the rhesus monkeys. About 1 km. from Galta is a valley known as monkey valley in which is located a Hanuman Temple. There is a large multimale group of approximately 60 langurs living around this temple. The priest of the temple feed the monkeys daily. The area is very dry and no rhesus were observed in this area.

Future

The future of the monkeys of Jaipur is unclear. Other than the monkeys that live in City Palace area, they are generally considered a nuisance. The monkeys are chased off using sticks or by making sudden noises. Occasionally monkeys have been poisoned. In the suburbs, trees have been eliminated in order to build more houses. The chasing of the monkeys and removal of trees has already had an

impact on at least the langur population as now the groups of Galta are larger than the groups of the City Palace area and the residential districts. Conversations with local inhabitants indicate that the monkeys are considered to be more of a nuisance than they were in the past. Because there are no past census data on the monkeys, it is not known if the monkey population has increased or if the increase in the human population has placed more pressure on the monkeys. We support those suggestions by Southwick and Siddiqui (1983, 1984), that in order to prevent the futher indiscrimate killing and human harassment of the monkeys they should be moved to areas away from human pressure and rehabilitated in more suitable places.

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BIRDS OF THE VISAKHAPATNAM GHATS, ANDHRA PRADESH[1]

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(*With three plates & three text-figures*)

We report the results of four field expeditions to the Visakhapatnam Ghats of Andhra Pradesh conducted between 1975 and 1985. These field surveys recorded 160 species of birds, including 22 species new to this montane area, 11 of which are first records for the Eastern Ghats. Important distributional records include the first peninsular records of *Malacocincla* (*Trichastoma*) *abbotti* and *Anthreptes singhalensis*; the first well-documented record of *Dinopium shorii* for the Peninsula; and first Eastern Ghats records of *Aviceda jerdoni, Dryocopus javensis,* and *Hemicircus canente*. Our findings support the contention that peninsular relicts are remnant humid forest forms and that the montane distribution of most of these species depends on the present availability of moist forest rather than a primary adaptation to upland habitats. Our recent surveys of sites first examined by the Vernay Expedition in 1930 show a significant reduction in forest habitat and a concomitant increase in developed and settled lands. It is suggested that forest fragmentation poses a serious threat to remaining populations of relictual moist forest birds.

Introduction

The modern configuration of the Indian Peninsula is defined by the western and eastern coastal ranges that face the Arabian Sea and Bay of Bengal, respectively, and which converge in southernmost India. The Western Ghats are higher, wetter and biotically richer than the Eastern Ghats, and for these reasons the Eastern Ghats have received relatively little attention by biologists. Regardless of past lack of attention, the Eastern Ghats figure prominently in the biogeography of the Indian Peninsula, and their study is necessary if we are to understand fully the distributional ecology of birdlife of the Subcontinent. These coastal mountains are important because of their influence on peninsular climate and biotic distributions, and, more recently, because they support the last tracts of remnant humid forest in the Peninsula and thus serve as an environmental refuge for the ever-more dissected populations of peninsular forest vertebrates.

In this paper we focus on studies of a segment of the Eastern Ghats — known either as the Visakhapatnam Ghats or the Northern Circars. We report on the results of four visits to this section of the ghats, conducted between 1975 and 1985. In addition, we discuss our observations in light of past studies of the region, to test the working hypothesis that significant man-related changes in the physical and biotic environment are affecting the distribution of the birdlife of the ghats.

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Past Studies in the Visakhapatnam Ghats

The most important single effort to survey the avifauna of the Eastern Ghats was conducted by the Vernay Expedition of the Bombay Natural History Society, with V. S. LaPersonne as chief field ornithologist. The team worked in the Eastern Ghats from April 1929 to June 1930, and sequentially surveyed from south (Salem District, presently Tamil Nadu) to north (various sites as far north as Balasore, Orissa).

The Visakhapatnam Ghats, the largest expanse of high mountains in Andhra Pradesh, were surveyed by LaPersonne between 4 February and 15 May 1930. That party worked at Anantagiri (900 m) from 4-28 February, at Sankrametta (1050 m) from 1 March-19 April, and at Jeypore (900 m) from 20 April to 15 May, 1930. That research produced a number of interesting discoveries including several subspecies new to science (*Sitta castanea prateri*, *Muscicapa poliogenys vernayi*, and *Rhipidura albicollis vernayi*).

Subsequent to that initial study, the region was visited by Abdulali (1945) in May 1944. In this trip, he briefly observed at Anantagiri, Sankrametta, and Lammasinghi (950 m), for a total of six days in the hills. Abdulali (1953) added additional records from the hills near Jeypore and Koraput (Orissa), based on records submitted by G. Gowland and N. A. Leslie. These two contributions by Abdulali added considerably to the avian records for the region, especially in documentation of the presence of open-country, or "plains" avifauna.

In the 1970s K. S. R. Krishna Raju established a bird-banding camp at Lammasinghi, and studied the birdlife in several parts of the Chintapalli plateau (Figure 1). Of greatest interest was his discovery of the first peninsular populations of the Tree Sparrow (*Passer montanus*; Krishna Raju & Price 1973), and the first record in the Eastern Ghats of the Little Spiderhunter (*Arachnothera longirostris*) (Krishna Raju & Selvin 1971).

Trevor Price (1979) spent a year (August 1976-August 1977) studying birds at the village of Lammasinghi. He netted and banded birds extensively, in order to study the effect of migrants on resident populations of forest birds. His study contributed a significant body of knowledge of the birds of the Eastern Ghats, and he made a number of "first records" for the region.

Field Program

The present paper summarizes the results of four field collecting expeditions to the Visakhapatnam Ghats. A party headed by Krishna Raju and other members of the Bombay Natural History Society visited Lammasinghi, Valaspara, and Sapparla in early 1975. The Ripleys, accompanied by Dr. Sálim Ali and Krishna Raju, visited the ghats briefly in March 1981 [Lammasinghi, Milerulu (940 m), Raghavendra Nagar (1000 m), and Lankapakalu (875 m)], making a small collection. Immediately following this, three members of the accompanying BNHS staff visited Bhadrachalam, on the southwestern edge of the Vizag Ghats, verging on the plains of the Godavari river, for the purpose of making a reconnaissance to search for Jerdon's Courser (*Cursorius bitorquatus*). This elusive species, not recorded by ornithologists since 1900, had been recorded from sites in the vicinity of the Vizag Ghats, Bhadrachalam being a locality where the bird had been collected. The party failed to find the courser there, but did make a small but interesting collection of birds, which is included here.

In 1983 Bruce Beehler and Shahid Ali, joined briefly by K. S. R. Krishna Raju and Dr. Sálim Ali, worked in Wangasara (800 m), Lammasinghi, Pedevalasa (1000 m), and

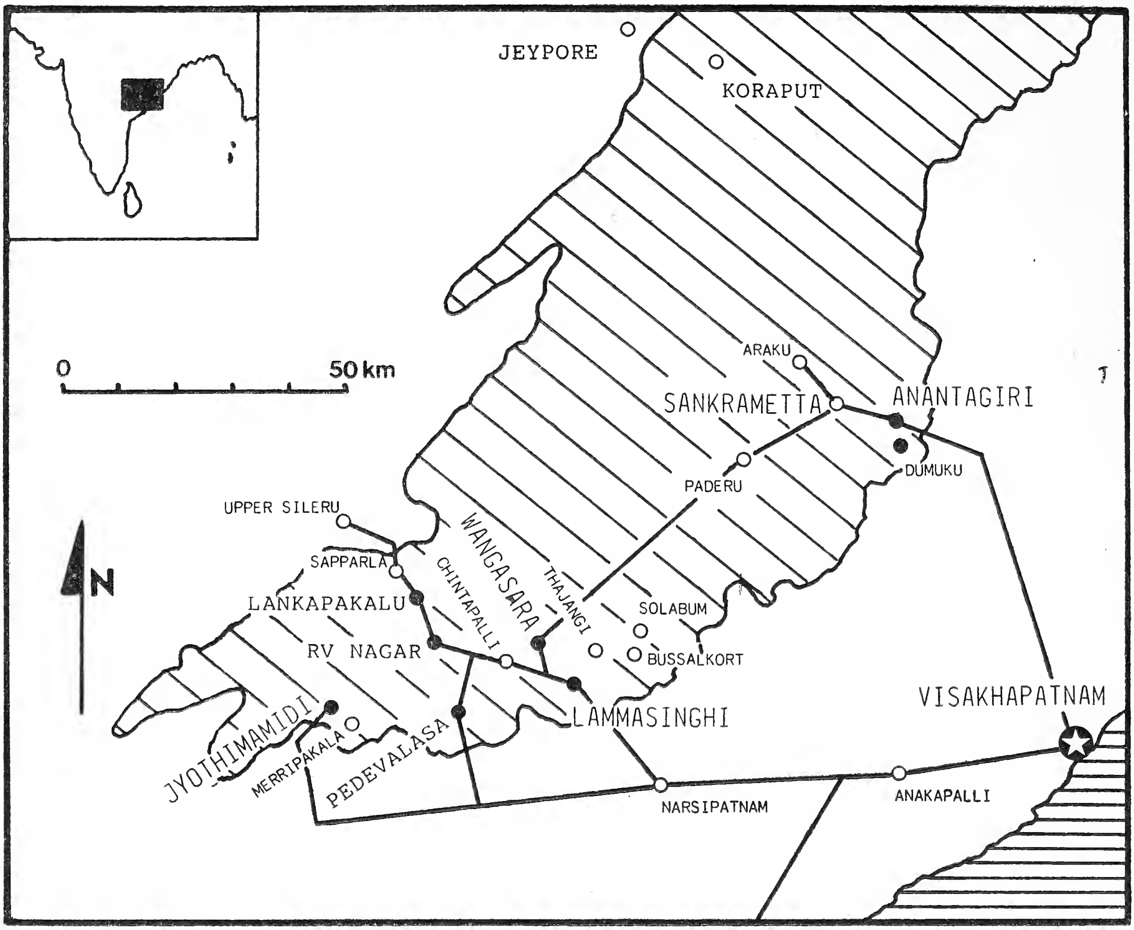

Fig. 1. Map of the Visakhapatnam Ghats, showing our research sites (solid circles) and sites visited by previous researchers (open circles). Some, but not all roads between sites are indicated, schematically. The uplifted region is indicated by the angled hatching, and the Bay of Bengal is indicated by the horizontal hatching in the lower left. Inset shows approximate region depicted by map.

Lankapakalu from 22 September to 26 October (see Figure 1).

Finally, between 19 February and 24 March 1984, the Ripleys and Beehler, accompanied by S. S. Saha, and C. K. Misra of the Zoological Survey of India, and P. B. Shekar of the Bombay Natural History Society, worked in the ghats at Jyothimamidi (450 m), Wangasara, Lankapakalu, and Anantagiri. This last field trip obtained more than 200 specimens of about 100 species, most of which were preserved as study skins, some as skeletons, and some as spirit specimens.

Methods

The goals of the fieldwork were twofold. A primary aim was to continue to document the distribution of birds through the ghats,

which to this day remain imperfectly known. A second goal was to begin to sample bird populations in differing habitats at different sites, in order to determine the extent to which large-scale habitat alteration through the ghats region has affected the structure and composition of local bird communities.

To this end we relied primarily on mist-nets for capturing and sampling birds. Large numbers of birds were captured, most of which were marked and released. Small numbers were preserved for taxonomic analysis and to serve as vouchers to the distributional study. In 1975, 1981, and 1985, collecting was with shotguns supplemented the samples taken with mist-net. This was particularly useful for canopy-dwelling species rarely taken in the nets.

Results

We recorded 160 species of birds in the Visakhapatnam Ghats during our four field trips. This includes 22 species new to the Visakhapatnam Ghats, 11 of which are first records for the Eastern Ghats as a whole, and 2 of which are first records for the Peninsula (Table 1). Considering that three groups

Table 1

Birds recorded for the first time in the Visakhapatnam Ghats

Species	First Record For: Vizag Ghats	Andhra Pradesh	Eastern Ghats	Peninsula
Bubulcus ibis	x			
Aviceda jerdoni	x	x	x	
Accipiter virgatus	x	x	x	
Falco peregrinus	x			
Columba punicea	x	x	x	
Cuculus sparvarioides	x	x		
Bubo bubo	x			
Ninox scutulata	x			
Strix leptogrammica	x			
Caprimulgus asiaticus	x			
Alcedo meninting	x	x	x	
Dinopium shorii	x			
Dryocopus javensis	x	x	x	
Hemicircus canente	x	x	x	
Dicrurus paradiseus	x			
Corvus splendens	x			
Malacocincla abbotti	x	x	x	x
Muscicapa muttui	x			
Prinia rufescens	x	x	x	
Myiophonus horsfieldii	x	x	x	
Turdus ruficollis	x	x	x	
Anthreptes singhalensis	x	x	x	x
Total	22	12	11	2

(LaPersonne, Abdulali, and Price) had worked the region previously, the fact that our sporadic studies established so many distributional records is clear evidence of how little we know of the avifauna. We would encourage continued study of this interesting biota.

Relictual distributions

Of the 160 species recorded from the Visakhapatnam Ghats, some 22 species can be considered relictual — bird species whose restricted populations in the Eastern Ghats' show closest affinity to populations in the Western Ghats, the Himalayan foothills, or Burma and Southeast Asia (Table 2). By all accounts this segment of the avifauna is the most interesting, biologically, and the most threatened by the encroachments of modern civilization.

The Peninsular distribution of these relicts is circumscribed, invariably confined to forest habitat in the ghats (Figure 2). This sort of distributional pattern is well-documented from a number of vertebrate and invertebrate taxa (Hora 1949, Ripley 1949, 1980, Ali 1969, Mani 1974), and defines a vicariance pattern that presumably was brought about by far-reaching

TABLE 2

RELICTUAL SPECIES IN THE VIZAG GHATS — PRESENT GEOGRAPHIC AND ALTITUDINAL DISTRIBUTION[1]

Species	Western Ghats	N.E. Hills	Himalaya	Southeast Asia[2]	Lowest Altitude[3]
Aviceda jerdoni	yes	yes	yes	to Sulawesi	sea level
Accipiter trivirgatus	yes	yes	yes	to Philippines	sea level
Accipiter virgatus	yes	yes	yes	to Sulawesi	sea level
Columba punicea	—	yes	—	to Indochina	sea level
Rhopodytes tristis	—	yes	yes	to Sumatra	sea level
Alcedo meninting	yes	yes	yes	to Lombok	sea level
Nyctyornis athertoni	yes	yes	yes	to Hainan	sea level
Picumnus innominatus	yes	yes	yes	to Malaya	sea level
Picus flavinucha	—	yes	yes	to Hainan	sea level
Dinopium shorii	?	yes	yes	to Burma	sea level
Dryocopus javensis	yes	yes	yes	to Philippines	sea level
Hemicircus canente	yes	yes	—	to Malaya	sea level
Gracula religiosa	yes	yes	yes	to Malaya	sea level
Dendrocitta formosae	—	yes	yes	to Hainan	sea level
Tephrodornis virgatus	yes	yes	yes	to Malaya	sea level
Malacocincla abbotti	—	yes	yes	to Malaya	sea level
Stachyris rufifrons	—	yes	yes	to Indochina	sea level
Macronous gularis	—	yes	yes	to Malaya	sea level
Muscicapa poliogenys	—	yes	yes	to Burma	above 3000′
Anthreptes singhalensis	—	yes	yes	to Malaya	sea level
Aethopyga siparaja	yes	yes	yes	to Sulawesi	sea level
Arachnothera longirostris	yes	yes	yes	to Malaya	sea level

[1] See text for full explanation of this table.

[2] We note the easternmost extension of the bird's range here.

[3] Is the bird strictly montane or does it occur at sea level in S.E. Asia?

 PLATE 1

Above: Looking northward from the plains north of the Godavari, to the heavily forested ghat-face of the Chintapalli plateau. Photo taken *c.* 15 km SE of Pedevalasa.

Below: Lankapakalu campsite at the edge of a permanent mountain stream. Most of the desirable habitat has been cleared of all undergrowth and converted to coffee plantations (see coffee in foreground and right portion of photograph). *Aviceda jerdoni* was collected in the pass above this camp.

(*Photos*: Author)

Jyothimamidi access road, passing through disturbed moist deciduous forest, late March 1985. Some canopy trees are beginning to lose their leaves. Habitat of *Anthracoceros malabaricus, Dicrurus paradiseus, Malacocincla abbotti,* and *Aethopyga saturata.*

Disturbed moist deciduous/semi-evergreen forest at Jyothimamidi. This hill forest habitat supported the richest assemblage of birds of any site we sampled in the ghats.

(*Photos*: Author)

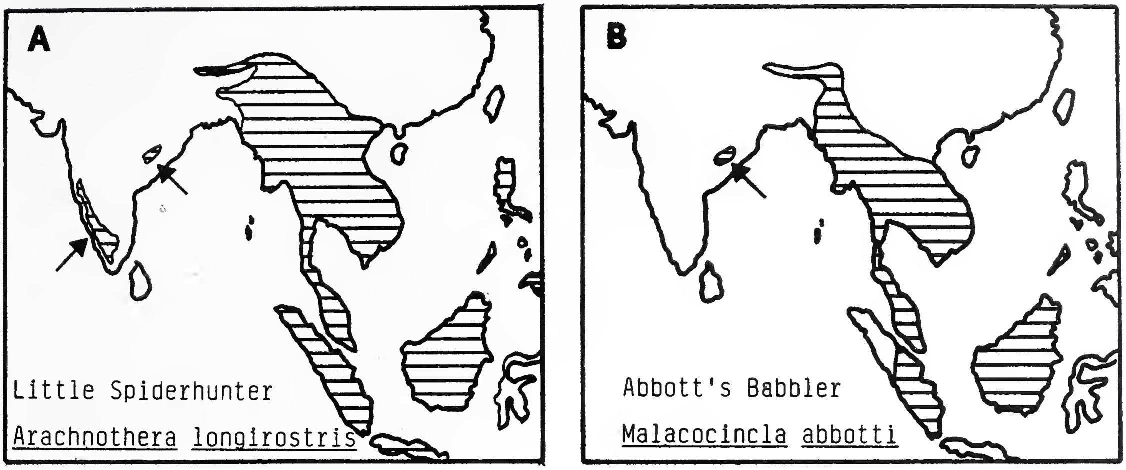

Fig. 2. Distributions of two 'relict' inhabiting the Vizag Ghats. Note the extent of their distributions in southeast Asia (horizontal hatching).

paleoecological events influencing entire biotas (cf. Cracraft 1982).

A major question concerning these relicts centers on the ecological reason for their present relictual distribution. S. L. Hora's "Satpura Hypothesis," sought to explain the anomaly of the northern forms in the far South by postulating a formerly continuous range of mountains higher than 6000 feet extending from the eastern Himalayas across the Peninsula via the Satpura/Vindhya hills, and thence to the Western Ghats. The assumption was that these forms actively 'dispersed' from southeast Asia, and the continuous chain of mountains was hypothesized as a dispersal pathway of a primarily montane fauna from the Himalayas down into southern India. This explained how mountain-loving forms were able to bridge the Garo-Rajmahal Gap and colonize what are now "islands" of montane habitat in the south.

As soon as the Satpura Hypothesis was published, Abdulali (1949) pointed out that it entirely overlooked the Eastern Ghats as a possible corridor of dispersal for Himalayan forms. This is a minor but correct criticism that highlights the long-overlooked importance of the Eastern Ghats as a habitat suitable for a relictual Himalayan biota. Mani (1974: 710ff) has provided a valuable and detailed critique of Hora's theory, and yet he failed, we believe, in presenting a cohesive alternative model for the distributional history of the biota.

We have two criticisms of the traditional explanations for the southern relicts. The first relates to the ecology of the relictual biota. Is the primary requirement of this relictual fauna cool montane habitat or humid forest? Hora studied "hill stream" fishes, and so his fauna was necessarily montane in nature. He believed his hill stream fishes required a continuous montane range in order to "disperse". We believe there is no geological evidence to prove a continuous range as postulated by Hora, and, in addition, we believe such a range is totally unnecessary to explain the present distribution of most relictual forms, especially

the birds. Many, indeed, most of the relictual forms that inhabit the mountains in South India occupy lowland rainforest in Burma and Southeast Asia.

As shown in Table 2, of the 22 peninsular relicts recorded in the Visakhapatnam Ghats, all but one occur in lowland forest in Southeast Asia, and many inhabit the Greater Sundas and Philippines, Pleistocene land-bridge islands that would have required colonization across extensive expanses of flat lowland habitat during periods when the sea-level was lower. The obvious conclusion is that many of the forms found to be relictual in the Indian Peninsula are confined to montane habitats not because of some 'cool montane' requirement, but because, at present, on the Indian Peninsula, humid forest remnants occur only in association with the mountains, which act to capture rainfall from water-bearing air masses off the Arabian Sea and Bay of Bengal.

Since the species in question are not strictly montane in nature, past distributions on the Peninsula did not necessarily correlate with mountain distributions, given the postulated presence, during earlier periods, of extensive tracts of humid forest on the plains (cf. Randhawa 1945, Ripley 1949, 1980, Prakash 1972). Thus, we postulate that the habitat favoured by the present-day relicts was, for some period, widespread on the Peninsula.

Our second criticism of the traditional biogeographic model devolves from the point made above. These hypotheses invoke the active movement of "propagules" from Southeast Asia, following a montane corridor, to the hills of South India, the last populations being "stranded" when the mountain corridor was broken by subsequent erosional events. We do not believe the colonization process occurred in this manner. Instead, following a "vicariance" model (Figure 3) we envisage the present relictual montane distributions being produced by a series of environmental changes in which a widespread, humid forest biota was dissected, with numerous local extirpations (cf. Cracraft 1982). We suppose that during a period of uniformly wet climate in Asia there was a "Humid South Asian" biota that extended, unbroken, from Sundaland westward through Southeast Asia to all India south of the Himalayas. At this time the humid forest fauna occurred throughout India, and the subcontinent supported a larger fauna than present today, one essentially identical to that in Southeast Asia. At that time when the environment was most humid, we assume that in areas of significant rain shadows there were dry "refuges" that supported relictual dry-habitat forms. Gradual dessication reversed the picture, and the humid forest forms withdrew into the wetter refuges near moisture-capturing mountain scarps, while the dry habitat forms expanded their distributions to the dominant state that they occupy today.

Empirical evidence is available which supports the vicariance model and contradicts predictions of the traditional scenario. The presence of a large relictual fauna on Sri Lanka cannot be explained by a continuous montane corridor (cf. Ripley 1949), but can easily be explained by a Pleistocene land connection in conjunction with the widespread humid environment. Additionally, if one must presume that all colonization followed the linear montane corridor, with a dispersal gradient from northeast to southwest, one would expect a "filtering effect" wherein many species dispersed shorter distances and fewer species dispersed longer distances. Such a filtering effect is not evident in present distributions. Indeed, the southern section of the Western Ghats supports the richest assemblage of Himalayan/ Northeastern Hill forms — a phenomenon

Above: Sapparla Village. The road that passes this village is the main transport route across the Chintapalli plateau. Regional development, including forest clearance has proceeded outward from this heavily-used road.

Below: Sapparla summit (*c.* 1200 m). The Lammasinghi-Upper Sileru road climbs over this high pass. Highest dome-like summits support large grassy expanses that are apparently edaphic subclimax grasslands, associated with rich deposits of bauxite.

(*Photos*: Author)

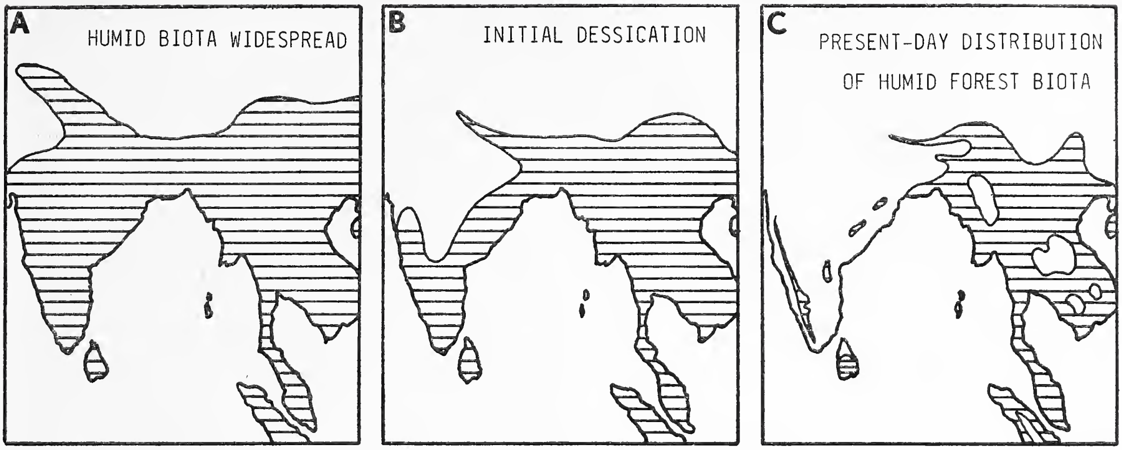

Fig. 3. Hypothetical sequence of contraction of a proposed widespread 'South Asian' humid forest biota. A. Humid forest at its presumed 'maximum', probably in the late Pleistocene. B.-C. Growing dessication and insularization of the biota. Present-day peninsular forest 'relicts' were stranded in humid refuges associated with the rain-capturing scarps of the coastal ranges. Note: coastal outlines are drawn based on present conditions.

easily explained by a combination of vicariance and island biogeographic theory. If the fauna were widespread at the peak humid period, during dessication the largest "islands" of humid habitat would retain the largest assemblages of the relictual biota.

Note, finally, that 9 of the 22 cited northern "relicts" to the Visakhapatnam Ghats are absent from the Western Ghats. Our vicariance hypothesis can explain this simply as a product of chance extinction during the period of dessication. Just as the Western Ghats retained many relicts that (by chance) went extinct in the Eastern Ghats, the Eastern Ghats retained, by chance, some of the former humid forest fauna that, by chance, was lost from the Western mountains. How can Satpura explain this phenomenon? Given the significant lowland barriers isolating the Visakhapatnam Ghats — the Mahanadi drainage to the north and Krishna and Godavari to the south, it is impossible to hypothesize a former continuous montane link to any former source of colonization, whether it be the Western Ghats or the Northeastern Hills.

We believe the processes that produced vertebrate distributions in the past are continuing to operate today. Thus with the continuing dessication and opening of the Indian forests from man-caused forest destruction, we can see an inverse, or "mirror" process in the expansion of the distributions of the dry-country forms. This process is not directional dispersal but instead a gradual growth of avian ranges based on expansion of available habitat. The presence of dry-country endemics in the Indian subcontinent (e.g. Jerdon's Courser or the Yellowthroated Bulbul *Pycnonotus xantholaemus*) may be remnants of a dry-country fauna that never recovered from the last humid phase, when reduction of the dry refuges in interior Deccan rain-shadows brought on the effective "genetic deaths" of some of the dry country species.

Migrants through the Visakhapatnam Ghats

Price's work at Lammasinghi has provided an initial look at the movement of migrants through the Eastern Ghats (Price 1979). Our survey recorded eighteen northern migrant species in the Vizag Ghats (Table 3). Of these, twelve are forest-dwelling forms, and probably depend on the Eastern Ghats as a habitat corridor for seasonal movement. The continued clearing of forest poses a direct threat to these forms either during passage or on their winter quarters. Fifteen of the eighteen migrant species are members of the family Muscicapidae, including the subfamilies Muscicapinae, Sylviinae, and Turdinae.

TABLE 3

NORTHERN MIGRANTS THROUGH THE EASTERN GHATS RECORDED BY OUR SURVEY

Circus aeruginosus
Streptopelia orientalis meena
Cuculus sparvarioides
Muscicapa latirostris
Muscicapa parva
Muscicapa superciliaris
Muscicapa rubeculoides
Muscicapa thalassina
Phylloscopus trochiloides ludlowi
Phylloscopus occipitalis
Seicercus burkii
Erithacus calliope
Erithacus brunneus
Monticola cinclorhynchus
Zoothera dauma
Zoothera wardii
Motacilla indica
Motacilla cinerea

The thrushes are the group that is probably most sensitive to habitat destruction. One of the species that requires good forest is the Blue Chat *Erithacus brunneus.* Our many records of this species indicate that it probably is a localized winter resident in the Eastern Ghats, inhabiting humid nullah vegetation and remnant patches of semi-evergreen forest. Ghats populations of this and other thrush species should be monitored in the future to determine their status.

Bird Populations past and present

The Vernay expedition surveyed bird populations in the Visakhapatnam Ghats for more than three months in 1930. How do their findings compare with ours, recorded more than fifty years later? It is difficult to directly compare their findings with ours for several reasons. First, The Vernay expedition published records of only 106 species from the region, fully 54 fewer than our list. At least with regard to their northern segment of the Eastern Ghats, the Vernay effort was not as thorough as ours. This can, in part, be accounted for by differences of method. We were able to deploy large numbers of mist-nets, an effective technique unavailable to the LaPersonne party. Mist-netting produced records of a number of species overlooked by the Vernay expedition: *Malacocincla abbotti, Arachnothera longirostris, Turdus ruficollis,* and *Alcedo meninting,* among others.

The Vernay survey recorded seventeen species not noted by our survey. Of these seventeen, all but perhaps one (*Turdus unicolor*) are widespread, open-country forms, not forest-dwellers. More than half of these have been recently recorded in the region by Price (1979). Thus the "raw data" offer no indication of any serious, ghats-wide loss of avifauna during the last 50 years. Of course, this crude comparison potentially misses any localized changes that, when added up, may produce increased insularization of remnant populations, which over the long run may spell doom for a number of species in the region.

In 1985 we visited Anantagiri, the type locality for *Muscicapa poliogenys vernayi* and other endemic populations. Since the Vernay survey worked there the region has been

heavily developed, with large tracts of coffee, intensively grazed areas, and much land under cultivation. Virtually no forest remains except in tiny sinuous strips following deep ravines that are relatively inaccessible. The area could be characterized as "severely disturbed", and the destruction of the original habitat is nearly total. We observed birds in the open habitats and mist-netted in three remnant patches of forest near watercourses. The remnant patches continue to support some of the "relict" species of greatest biological interest. But these populations were, without question, tiny, vulnerable, and isolated from nearest sources of colonization. The forest-dwelling birdlife in this region appears severely threatened.

By contrast, the open-country species, most of which have colonized this upland region from the plains, are abundant in the Anantagiri environs. The man-caused environmental dessication that we witnessed at Anantagiri and in other sections of the Northern Circars is causing a faunal transition, on a local scale, similar to that which we invoked to explain the present distribution of the northern "relict" species. The habitat is opened, surface albedo is raised, annual air temperature increases, and available moisture is reduced. Humid forest forms retreat into protected pockets, and the open-country forms increase in distribution and abundance. Anantagiri, formerly a large forested plateau supporting a distinct regional avifauna has become a disturbed region that environmentally is similar to the plains, with an avifauna that is no longer regionally distinctive. Meteorological records based on incomplete evidence indicate a mean increase of more than 10°C in annual temperature range along the eastern edge of the escarpment.

One apparent exception to the ongoing expansion of the "plains" or open country fauna is Jerdon's Courser, one of India's least-known birds. After the 1981 field trip, the senior author and Dr. Sálim Ali encouraged a small BNHS contingent of the field party to spend several days searching for the bird near Bhadrachalam, on the southwestern flank of the Vizag Ghats. While this and several subsequent attempts failed, five years of effort by the BNHS paid off when in early 1986 a single Jerdon's Courser was trapped near Cuddapah, in southernmost Andhra Pradesh. Many had considered the species extinct. What efforts will now be made to ensure that the courser does not become one of the "lost" before this decade is out, remains to be determined. An all-out effort to learn the habits and habitat-requirements of this apparently crepuscular species should be mounted as soon as possible.

Habitat destruction

The conversion of upland forest into open land has been brought about by several forces. Beginning before Independence, areas in the Northern Circars had been developed by the Department of Forests for plantations of coffee and teak. This has continued and expanded, although with greater planning in more recent years. The forestry program also supports the cropping of bamboo stands, as well as selective timber-extraction from "miscellaneous forest". At the same time, the region has seen an influx of tribal groups from Orissa. These settlers, at odds with the attempts at control by the government, have been politicized, and often act at cross-purposes to the Forest Department, the result being expanded destruction of habitat. Tribal groups, in an attempt to circumvent the control of the land by Forestry, clear-fell large areas, putting them into cultivation in order to gain ownership of the land by its visible development and occupation.

The outcome of this political struggle is that the Ghats are being increasingly threatened

with complete destruction. There are no undisturbed flat tracts of forest on the several plateau expanses that constitute the Northern Circars. The only remaining significant forest is to be found on the ghat slopes and in the rather remote foothills in the southwestern reaches of the uplifted region (e.g. Jyothimamidi). There is no certainty that even fragments of these tracts will be set aside before they are permanently altered. The future of the forest avifauna in Vizag Ghats is thus in real danger.

ANNOTATED LIST

Following the sequence and nomenclature of Ripley (1982) we present brief species accounts of all birds recorded in our surveys. All localities cited in the accounts are plotted on the map in Figure 1. All linear measurements are made in millimetres, all weights are in grammes. Except where noted, culmen measurement is from base of the skull, and wing measurement is chord, as measured with dividers from the bend in the wing to the tip of the longest primary.

44. **Bubulcus ibis** (Linnaeus).
CATTLE EGRET.

Observed in tight flocks near Chintapalli and north of Pedevalasa, March 1979. Roosted in low trees bordering large fields near villages.

124. **Elanus caeruleus vociferus** (Latham).
BLACKWINGED KITE.

Specimens: 1 male (imm.), Bhadrachalam, 12 March 1975.

Measurements: wing 273, culmen (damaged), tail 127.

Notes: A single bird was observed over a plowed field at Lankapakalu.

125. **Aviceda jerdoni jerdoni** (Blyth).
BLYTH'S BAZA.

Specimens: 1 female (ova very slightly enlarged), Lankapakalu (909 m), 16 March 1985.

Measurements: wing 320, culmen (from cere) 22, tail 218, weight 470.

Soft parts: iris golden yellow, legs dead white, claws black, maxilla and cere black, blue-grey basally, mandible basally blue-grey, with a black tip and black splotch on tomium.

Taxonomy: agrees in size with the northern race *jerdoni*. In plumage it appears identical to specimens from southeast Asia.

Distribution: a first record for the Eastern Ghats. S. S. Saha reported sighting this species at Jyothimamidi in February 1985. Could this individual represent a migrant?

Notes: shot from the canopy of a low tree at the edge of a dirt track through a coffee plantation. Specimen was a non-breeding female; one ovum measured 4 mm.

129-130. **Pernis ptilorhyncus** (Temminck).
HONEY BUZZARD.

Observed at Lammasinghi, 27 October 1983.

132-134. **Milvus migrans** (Boddaert).
PARIAH KITE.

Observed on several occasions on the Chintapalli plateau during March 1985. Taken at Jeypore by the Vernay Expedition.

138. **Accipiter badius dussumieri** (Temminck).
INDIAN SHIKRA.

Specimen: 1 male (testes enlarged), Anantagiri, 20 March 1985.

Measurements: wing 179, culmen (from cere) 12.5, tail 140, weight 118.

Soft parts: iris pinkish red, legs olive-yellow, bill black with grey base, cere greenish grey.

Notes: Collected in roadside scrub.

144. **Accipiter trivirgatus indicus** (Hodgson).
NORTH INDIAN CRESTED GOSHAWK

Specimens: 1 male (t.e.), Jyothimamidi, 24 February 1985. 1 male (t.s.e.) Wangasara, 4 March 1985; Also mist-netted at Wangasara, October 1983.

Measurements: (male) wing 223, 226, culmen (from cere) 18, 16.5, tail 177, 175, weight 293, 280. Unsexed (netted) weight 316, 322.

Soft parts: (male) iris orange, unsexed (netted = ♀?) yellow, deep yellow, legs olive-yellow, (netted unsexed) corn yellow, cere dull orange, gape and base of mandible yellow, maxilla black with a blue-grey base.

149-152. **Accipiter virgatus** (Temminck).
BESRA SPARROW-HAWK

Specimens: 1 unsexed (mist-netted and released) Wangasara, 28 September 1983.

Measurements: wing (chord) 152, tail 122, tarsus 50, bill (from cere) 11, (from feathers) 15.5, weight 114.

Soft parts: iris orange, cere yellowish green.

Notes: throat white with some fine dark streaking. Sides of breast almost solid cinnamon grading into obscure barring on lower breast, flanks and thighs. Wing, tail and body moult was present.

172. **Ictinaetus malayanus** (Temminck).
BLACK EAGLE.

Observed at Wangasara, October 1983, and at Jyothimamidi, February 1985.

193. **Circus aeruginosus** (Linnaeus).
MARSH HARRIER.

Observed at Lankapakalu, March 1985.

197. **Spilornis cheela melanotis** (Jerdon).
LESSER CRESTED SERPENT EAGLE.

Specimen: 1 male (t.n.e.) Wangasara, 12 Mar. 1985.

Measurements: wing 439, culmen 31.5, tail 265.

Soft parts: iris yellow, legs corn yellow, cere and orbital skin yellow, bill blue-grey with a black tip.

Notes: A pair was observed mating on the ground on the roadside at Jyothimamidi, 24 February 1985.

221. **Falco peregrinus peregrinator** (Sundevall).
SHAHIN FALCON.

Observed at Lammasinghi, 27 October 1983.

275. **Galloperdix spadicea spadicea** (Gmelin).
RED SPURFOWL.

Specimen: 1 female (ova enlarged) Valaspara, near Sileru, 16 March 1975.

Measurements: wing 150, culmen 21, tail 111.

299. **Gallus gallus** (Linnaeus).
RED JUNGLEFOWL

Observed at Wangasara, October 1983; Jyothimamidi, February 1985; Lankapakalu, March 1985.

Notes: common in forest and coffee plantations in most parts of the Chintapalli plateau.

311. **Pavo cristatus** Linnaeus.
COMMON PEAFOWL.

Observed at Jyothimamidi, February 1985.

Notes: Common and vocal throughout the forest at Jyothimamidi; extirpated from most areas of the Chintapalli plateau.

314. **Turnix tanki tanki** Blyth.
INDIAN YELLOWLEGGED BUTTON QUAIL.

Specimens: 1 male, Valaspara, near Sileru, 16 March 1975; 1 female (o.n.e.) Lammasinghi, 24 February 1981.

Measurements: (male) wing 77, culmen 14, tail 25.5; (immature female) wing 89, culmen 15, tail 35, weight 58.

Soft parts: (female) iris yellow, legs rich yellow, maxilla dark brown, tomium yellow, mandible yellow with a brown tip.

501. **Treron bicincta bicincta** (Jerdon).
INDIAN ORANGEBREASTED GREEN PIGEON.

Specimens: 1 female (o.s.e.), 1 male (testis 6 × 15 mm) Jyothimamidi, 27, 28 February 1985; 1 female (ova granular) Wangasara, 28 February 1985.

Measurements: (male) wing 156, culmen (base) 18.5, tail 91, weight 165; (females) wing 155, 163, culmen (base) 19, 19.5, tail 85 (2), weight 138, 149.

Soft parts: (male) iris inner blue, outer pink, legs cherry to mauve pink, bill generally pale turquoise with blue supra-naral patch and greyish ivory tip; (females) iris (a) inner blue, outer ivory, (b) inner blue, outer pinkish orange, legs (a) cherry with dirty white pads of feet, (b) cherry, bill (a, b) tip pale grey-white.

506-507. **Ducula aenea sylvatica** (Tickell)/ **pusilla** (Blyth).
GREEN IMPERIAL PIGEON.

Specimens: 1 female, Bhadrachalam, 12 March 1975.

Measurements: wing 223, culmen 28, tail 120.

Taxonomy: This specimen is small for typical *sylvatica* but large for typical *pusilla.* It seems clear that these two peninsular races are end-points on a cline and probably should be united, as suggested by Abdulali (1971).

Notes: In 1985, one of us (SDR) observed pigeons flying high over a clearing at Lankapakalu that appeared to be of this species.

524. **Columba punicea** Blyth.
PURPLE WOOD PIGEON.

Specimens: 1 male (testis 17 × 6 mm), 1 female (oviduct swollen, ova forming) Jyothimamidi, 24 February 1985.

Measurements: (male) wing 225, culmen (base) 28.5, tail 153, weight 367; (female) wing 221, culmen (base) 27, tail 127, weight 320.

Soft parts: (male) iris red (outer), orange (inner), legs with cherry red tarsal scutes, sides dull purple, nails pale horn, bill vinaceous purple base, grey-green tip; (female) iris red (outer), orange (inner), legs with cherry red tarsal scutes, bill as for male.

537-541. **Streptopelia chinensis** (Scopoli).
SPOTTED DOVE.

Mist-netted at Wangasara, 27 September 1983.

Weights: (unsexed) 105, 110, 124.

Soft parts: (unsexed) iris (a) pink, (b) orange-red, (c) pink.

Notes: netted birds showed no moult.

531. **Streptopelia orientalis meena** (Sykes).
WESTERN TURTLE-DOVE.

Specimen: 1 male (t.n.e.) Dumuku village, nr. Anantagiri, 21 March 1985.

Measurements: wing 194, culmen 25.5, tail 116, weight 202.

Soft parts: iris orange, legs purplish cherry, eye-ring and subocular patch mauve, bill dark violet with a mauve tip.

Taxonomy: Presumably a winter visitor to the region.

Notes: This bird was taken in disturbed open country.

533. **Streptopelia orientalis erythrocephala** (Bonaparte).
PENINSULAR TURTLE-DOVE.

Specimens: 1 (unsexed) Raghavendra Nagar, 1 March 1981; 1 male (t.n.e.), Jyothimamidi, 2 March 1985; 1 female (o.e.) Lankapakalu, 13 March 1985.

Measurements: (male) wing 181, culmen 23.5, tail 115, weight 183; (female) wing 172, culmen 24.5, tail 112, weight 195; (unsexed) wing 178.5, culmen 25, tail 107, weight 198.

Soft parts: (male) iris dull orange, legs dark cherry, orbital skin and base of bill purplish cherry, tip of bill brownish horn; (female) iris dark brown, legs dark cherry-red, eyelids dark cherry, bill dark cherry shading to dark greenish grey; (unsexed) iris orange, legs dull rose, cere and eyelid pink.

Notes: voice is a raucous and grating *coo* (Jyothimamidi, 2 March 1985). Closed forest.

542. **Chalcophaps indica indica** (Linnaeus).
INDIAN EMERALD DOVE.

Specimens: 1 female (o.n.e.), Jyothimamidi, 22 February 1985.

Measurements: wing 172, culmen 23.8, tail 71.5, weight 107.

Soft parts: iris dark brown, legs burgundy red, bill brown basally and coral distally.

Notes: no moult. Mist-netted in forest. This species was abundant at Jyothimamidi. We netted more than 20 individuals.

558. **Psittacula cyanocephala cyanocephala** (Linnaeus).
SOUTHERN BLOSSOMHEADED PARAKEET.

Specimens: 2 males (t.e., imm.), 1 (unsexed) Jyothimamidi, 25 February, 2 March 1985.

Measurements: (males) wing 135, 141.5, culmen (cere) 18, 17.5, tail 189, 215, weight 62, 67; (unsexed) wing 124, culmen 16, tail 122, weight 55.

Soft parts: (males) iris pale tan, dark orange, legs grey or greenish grey, maxilla orange (2), mandible black (2); (unsexed) iris dark yellow, legs dull greenish grey, maxilla yellowish ivory, mandible horn-grey.

566. **Loriculus vernalis** (Sparrman).
INDIAN LORIKEET.

Specimens: 1 male (testis 2 × 3 mm) Jyothimamidi, 25 February 1985; 1 male (t.s.e.), Lankapakalu, 16 March 1985.

Measurements: (males) wing 83, 90, culmen (from cere) 11, 11.8, tail 41.5, 37, weight 31, 35.

Soft parts: iris dark brown or pale whitish cream, legs dull yellow-tan or dull yellowish olive, bill orange or reddish orange.

572. **Cuculus sparvarioides sparvarioides** Vigors.
LARGE HAWK-CUCKOO.

Specimens: 2 immature females (o.n.e.), Jyothimamidi, 23, 25 February 1985.

Measurements: wing 228, 239, culmen 29, 30, tail 185, 186, weight 130, 145.

Soft parts: iris tan or dark brown, legs corn yellow, maxilla black, mandible yellow or yellow-green, black distally.

Notes: Both specimens were taken in disturbed forest.

573. **Cuculus varius varius** Vahl
COMMON HAWK-CUCKOO.

Specimens: 1 immature male (t.n.e.), 1 male (t.n.e.) Wangasara, 5, 9 March 1985.

Measurements: (male) wing 201, culmen (from base) 26.5, tail 153, weight 102; (immature) wing 189, culmen 27.5, tail 160, weight 84.

Soft parts: (male) iris orange, legs ivory yellow, maxilla black, mandible greenish grey, eye-ring yellow; (immature) iris pale tan, legs orange yellow, bill dull green with a black tip, eye-ring yellow.

582-583. **Cacomantis sonneratii** (Latham).
BAYBANDED CUCKOO.

Observed at Wangasara, October 1983 and March 1985, Pedevalasa, October 1985.

588. **Surniculus lugubris dicruroides** (Hodgson).
INDIAN DRONGO-CUCKOO.

Observed at Wangasara, 4 October 1983. Keys to identification were the barred tail coverts and outer tail feathers, and white spots on crown.

590. **Eudynamys scolopacea scolopacea** (Linnaeus).
INDIAN KOEL.

Specimens: 1 male (t.n.e.), Lankapakalu, 15 March 1985.

Measurements: wing 197, culmen (base) 31, tail 199, weight 160.

Soft parts: iris red, legs blue-grey, bill pale greenish horn.

593. **Rhopodytes tristis tristis** (Lesson).
LARGE GREENBILLED MALKOHA

Specimens: 1 female (o.n.e.), Jyothimamidi, 24 February 1985.

Measurements: wing 160, culmen (base) 35, tail 345, weight 105.

Soft parts: iris reddish brown, legs dark bluish gray-black- bill olive greyish green, eye-patch carmine red to dull mauve on nares.

597. **Taccocua leschenaultii infuscata** Blyth.
EASTERN SIRKEER CUCKOO

Specimens: 1 male, Bhadrachalam, 12 March 1975.

Measurements: wing 161, culmen 32, tail 187.

Notes: the Vernay Expedition took a specimen at Sankrametta.

602. **Centropus sinensis parroti** Stresemann.
SOUTHERN CROW-PHEASANT.

Specimens: 1 male (t.n.e.), Anantagiri, 22 March 1985.

Measurements: wing 182, culmen (base) 41, tail 245, weight 258.

Soft parts: iris red, legs black, bill black.

616, 617. **Otus scops sunia** (Hodgson)/**Otus scops rufipennis** (Sharpe).
NORTHERN SCOPS OWL/PENINSULAR SCOPS OWL.

Specimens: 3 males (–, t.e., t.e.), 1 female (o.e.), Jyothimamidi, 25 February, 1, 2 March 1985; 1 male (t.e.), Wangasara, 10 March 1985.

Measurements: (males) wing 130, 133.5, 134, 140, culmen (base) 19, 19.5 (2), 21, tail 52, 53, 53.5, 57, weight 58, 60 (2), 64; (female) wing 137, culmen 19, tail 60, weight 75.

Soft parts: (male) iris lemon yellow or yellow, legs pale brown or dirty greenish, pads yellow ochre, nails dirty flesh, bill dark brown, dark greenish, or dirty greenish yellow, tomia horn; (female) iris lemon yellow, legs dirty greenish brown, pads yellowish, bill greenish horn with dull yellow tip.

Notes: This series keys out by wing formula to *sunia* but by wing-length to either *sunia* or *rufipennis.* Overall measurements generally refer to *rufipennis.* This series shows remarkable plumage polymorphism, with dorsal colour ranging from grey, heavily streaked and vermiculated, to rufous and streaked, to rufous and virtually unstreaked. These differences are reflected in ventral coloration, as well.

623. **Otus bakkamoena bakkamoena** Pennant.
CEYLON COLLARED SCOPS OWL.

Specimens: 1 male (t.s.e.), Lankapakalu, 14 March 1985.

Measurements: wing 164, culmen 22.5, tail 80.5, weight 128.

Soft parts: iris rich mahogany brown, legs greyish brown, bill greyish ivory basally, mandible blue-grey ivory with paler tip, cere ivory with blue-grey tinge.

Taxonomy: This specimen keys out in HANDBOOK to *lettia.* By distribution it should be *bakkamoena.* Examination of the copious USNM holdings provide no clues to the subspecific identity of our specimen. Abdulali (1972: 108) reported a BNHS specimen from Lammasinghi (wing 170, bill 23, tail 8). His determination agrees with that of this paper — in size conforming with *lettia,* but *bakkamoena* by distribution.

625-627. **Bubo bubo.**
EAGLE-OWL.

Heard at Pedevalasa, 18 October 1983 (call: *buu bo*); heard at Jyothimamidi, 22 February 1985.

Notes: Another (unidentified) species of *Bubo* was recorded at Lammasinghi, 23 September 1983, at Pedevalasa, 15 October 1983, and at Lankapakalu, 20 October 1983. The

call was a very low-pitched *hoo — hoohoohoo,* each series given every 10 sec. In both instances two birds were heard calling to each other. This call may belong to the next species.

631. **Bubo zeylonensis leschenault** (Temminck) BROWN FISH OWL.

Specimen: 1 male (t.n.e.), Lankapakalu, 17 March 1985.

Measurements: wing 402, culmen (base) 50, tail 196, weight 1200 g.

Soft parts: iris orange-yellow, legs dull blackish grey, pads of feet pinkish flesh, nails bluish ivory to ivory, bill blue-grey, cere dark grey-black.

636. **Glaucidium radiatum radiatum** (Tickell). BARRED JUNGLE OWLET.

Specimens: 2 females (o.e., o.n.e.), Jyothimamidi, 24, 28 February 1985.

Measurements: wing 121, 125, culmen (base) 18 (2), tail 58.3, 59, weight 83, 91.

Soft parts: iris pale yellow or chrome yellow, legs dull yellowish brown or dirty yellow with yellow pads, bill greyish ivory or greenish yellow.

642-645. **Ninox scutulata** (Raffles). BROWN HAWK-OWL.

Observed at Raghavendra Nagar in March 1981.

659. **Strix leptogrammica indranee** Sykes. BROWN WOOD OWL.

Specimens: two feathers of this taxon were taken from a mist-net at Lankapakalu in October 1983.

Notes: the species was observed at Pedevalasa, 18 October 1983. It was attracted into close view by an imitation of its distinctive call, a vocalization typical of the genus: *hooa HooHooHooA*.

671. **Caprimulgus indicus indicus** Latham. INDIAN JUNGLE NIGHTJAR

Specimens: 1 male (o.n.e.) Jyothimamidi, 28 February 1985; 1 male (t.e.), Anantagiri, 20 March 1985; (tail feathers), Lankapakalu, 17 March 1985.

Measurements: (males) 186, 198, culmen 22, 25, tail 122.5, 123, weight 63, 68.

Soft parts: iris dark brown or brown, legs brown with a greyish cast or greyish brown, pads of feet dark or pale flesh, bill blackish brown or dark brown.

675. **Caprimulgus macrurus albonotatus** Tickell INDIAN LONGTAILED NIGHTJAR.

Specimens: 2 males (t.e.), Wangasara, 6, 8 March 1985.

Measurements: wing 212, 217, culmen 19, 21.5, tail 142, 162. weight 69, 79.

Soft parts: iris dark brown (2), legs pale brown or brownish flesh, bill horn with a black tip, dark brown.

Taxonomy: This and the following form (*atripennis*) were taken at the same site and both were in breeding condition. In full agreement with the detailed arguments of Mees (1985), Ripley & Beehler (1987) treat the two forms as distinct species, with the Wangasara specimens providing evidence for this position. The Vernay Expedition took a specimen of *albonotatus* from Anantagiri.

676. **Caprimulgus atripennis** Jerdon. JERDON'S LONGTAILED NIGHTJAR.

Specimens: 1 male (t.e.), Wangasara, 6 March 1985.

Measurements: wing 182, culmen 26, tail 109, weight 55.

Soft parts: iris dark brown, legs maroon grey, bill dark brown.

Taxonomy: This is a well-defined population that is easily keyed out. Following Mees (1985), we treat it as a full species (see preceding account).

680, 681. **Caprimulgus asiaticus** (Latham).
LITTLE NIGHTJAR.

A specimen was caught by hand and subsequently released at Lankapakalu, October 1983.

694. **Apus melba nubifuga** Koelz.
INDIAN ALPINE SWIFT.

Specimens: 1 female, Bhadrachalam, 12 March 1975.

Measurements: wing 200, culmen 15.5, tail 69.5.

707-708. **Cypsiurus parvus** (Lichtenstein).
PALM SWIFT.

Observed at Wangasara in October 1983.

709. **Hemiprocne longipennis coronata** (Tickell)
CRESTED TREE SWIFT.

Specimens: 1 male (t.n.e.), Jyothimamidi, 27 February 1985; 1 male (t.s.e.), Wangasara 6 March 1985.

Measurements: wing 149, 158, culmen (base) damaged, 12.8, tail 114, 118, weight 27.5, 28.5.

Soft parts: iris brown or dark brown, legs black or purplish grey, bill black (2).

711. **Harpactes fasciatus malabaricus** (Gould).
MALABAR TROGON.

Specimens: 1 female (o.n.e.), Lankapakalu, 23 October 1983; 1 female (o.n.e.), 1 male (t.s.e.), Jyothimamidi, 23, 25 February 1985.

Measurements: (male) wing 129, culmen 19.5, tail 154, weight 65; (females) wing 123, 133, culmen 19.5, 21, tail 156, 163, weight 51, 57.

Soft parts: (all) iris dark brown, legs blue-grey; (male) bill dark bluish, eye-ring blue; (female) foot pads dirty-white, nails brown, orbital skin dull blue or purplish blue, bill purplish blue with a black tip.

723. **Alcedo atthis bengalensis** Gmelin.
INDIAN SMALL BLUE KINGFISHER.

Specimens: 1 male (t.n.e.), Dumuku village, nr. Anatagiri, 21 March 1985.

Measurements: wing 73.5, culmen 49, tail 35, weight 25.

Soft parts: iris dark brown, legs brownish orange, bill black, gape dull orange, in moult.

Taxonomy: This specimen conforms to *bengalensis* by measurements and dorsal coloration. This may be either a southern outpost of this race in the peninsula, or else a wandering individual.

725. **Alcedo meninting coltarti** Baker.
ASSAM BLUE-EARED KINGFISHER.

Specimens: 1 unsexed, 1 female (o.n.e.), Lankapakalu, 23 October 1983, 13 March 1985; 1 female (o.n.e.), Jyothimamidi, 25 February 1985.

Measurements: (males) wing 70, 71, culmen 45.5, 47.5, tail 30, 31.5, weight 27, 28; (unsexed) wing 72.5, culmen 47, tail 30, weight 26.

Soft parts: (males) dull orange or dark brown, legs coral or cerise, maxilla dark brown, suffused with deep coral on ramus, or black, nares and gape dull red, mandible deep coral, or basally black and dark red tip; (unsexed) iris dark brown, legs coral red, mandible coral red.

Notes: These represent first records for the Eastern Ghats.

753. **Nyctyornis athertoni athertoni** (Jardine and Selby).
BLUEBEARDED BEE-EATER.

Specimens: 1 male (o.n.e.), Jyothimamidi, 2 March 1985.

Measurements: wing 137.5, culmen 50, tail 120, weight 92.

Soft parts: iris pale orange brown, legs yellowish olive, maxilla blackish, base of tomium and mandible pearly grey.

763-765. **Upupa epops** (Linnaeus).
HOOPOE.

Observed at Pedevalasa, 16 October 1983.

774. **Anthracoceros malabaricus** (Gmelin).
PIED HORNBILL.

Commonly encountered in small flocks at Jyothimamidi in late February 1985. A single pair was found at Wangasara in October 1983, but not seen on the return stay in March 1985. This species has been extirpated from most areas of the Visakhapatnam Ghats. Presumed causes for this are hunting and forest clearance.

Notes: The observation at Wangasara (800 m) may represent an altitudinal record.

780. **Megalaima zeylanica caniceps** (Franklin).
NORTHERN GREEN BARBET.

Specimens: 1 female (o.n.e.) Pedevalasa, 20 October 1983; 1 male (t.s.e.), Wangasara, 9 March 1985.

Measurements: (male) wing 114, culmen 32, tail 72, weight 99.5, (female) wing 116, culmen 34.5, tail 66.5, weight 96. Mist-netted (unsexed) weight 120, 121.

Soft parts: (male) iris brown, legs dull yellow, eye-patch orange-yellow, bill dull pinkish brown, gape whitish; (female) iris pale grey-brown, legs straw yellow.

Notes: In late September and early October numbers of these barbets foraged on the fruits of *Bursera serrata.* Call was a soft-trilled *kd-d-d-d-d,* repeated.

792. **Megalaima haemacephala indica** (Latham)
CRIMSONBREASTED BARBET.

Specimens: 1 female (o.n.e.), Wangasara, 8 March 1985.

Measurements: wing 80.5, culmen 17.8, tail 32.5, weight 33.5.

Soft parts: iris brown, legs dull orange-red, bill black, base of mandible and gape grey.

799. **Picumnus innominatus malayorum** Hartert.
SOUTHERN SPECKLED PICULET.

Specimens: 1 female (ova. undev.), Lammasinghi, 26 October 1983; 1 female (o.s.e.), Jyothimamidi, 1 March 1985; 1 male (t.e.), Lankapakalu, 14 March 1985.

Measurements: (male) wing 60, culmen 12.2, tail 31.5, weight 11; (females) wing 60, 61, culmen 12.5 (2), tail 32.5, 34.5, weight —, 10.8. Mist-netted birds: (males) weight 10.8, 11.9; (unsexed) 11, 11.4.

Soft parts: (all) iris dark brown, legs blue-grey, bill black with blue-grey base to mandible.

803. **Micropternis brachyurus phaioceps** Blyth.
EASTERN RUFOUS WOODPECKER.

Specimens: 2 males (t.n.e.), 1 female (o.e.) Lankapakalu, 13, 14 March 1985.

Measurements: (males) wing 123, 124.5, culmen 31, 31.4, tail 58, 64, weight 90, 97; (female) wing 128, culmen 31, tail 60.5, weight 90. Mist-netted (unsexed female-plumaged) weight 81 g.

Soft parts: (males) iris reddish brown or dark brown, legs brownish black, bill black, nares, edge of gape, and center of edge of mandible shaded and edged with olive-grey; (female) iris reddish brown, legs and bill as in male.

Taxonomy: The subspecies key in the HANDBOOK is unsatisfactory. Throat pattern is not reliable, as all of the specimens we examined showed a squamated, not streaked, throat. The birds collected by the Vernay Expedition at Anantagiri were identified as *phaioceps.*

Notes: Our female taken in mid-March carried two ova in the oviduct.

813. **Picus flavinucha flavinucha** Gould.
EASTERN LARGE YELLOWNAPED WOODPECKER.

Specimens: 1 male (—), Upper Sileru, 18 March 1975; 1 male (t.n.e.), Jyothimamidi,

27 February 1985; 1 female (o.s.e.), Lankapakalu, 15 March 1985.

Measurements: (male) wing 168.5, culmen 45, tail 126, weight 150; (females) wing 162.5, 179, culmen 41, 41.5, tail 102, 104.

Soft parts: (male) iris brownish red, legs grey-black, bill grey; (females) iris dark brown, legs dull greenish grey, bill blue-grey.

Notes: Call is an explosive *kchaer*! — like a loud sneeze but somewhat musical and guttural, lower-pitched than call of *P. macei.*

815. **Picus chlorolophus chlorolophus** Vieillot.
EAST HIMALAYAN SMALL YELLOWNAPED WOODPECKER.

Specimens: 1 male (t.s.e.) Raghavendra Nagar, 1 March 1981; 2 males (t.s.e.), Lankapakalu, 17 March 1985.

Measurements: (males) 128, 130, 131, culmen 28, 29, 29.5, tail 79, 87 (2), weight 59.5, 68, 69.

Soft parts: (males) iris reddish brown, legs dull greenish grey, blackish or blackish olive, maxilla slaty black or black, mandible either dull olive-yellow basally, and slaty-tipped, with base of ramus dull yellow, or greenish grey with a black tip.

Taxonomy: The Raghavendra Nagar male lacks the red malar stripe. All three specimens show the bronzy-red on the outer veins of the inner primaries. Eastern Ghats material in the collection of the Bombay Natural History Society has been identified as the nominate subspecies. Our three specimens show wing length longer than *chlorigaster* and agree well with Burmese material.

824. **Dinopium shorii shorii** (Vigors)
HIMALAYAN GOLDENBACKED THREE-TOED WOODPECKER.

Specimens: 1 female (—), Jyothimamidi, 2 March 1985.

Measurements: wing 155.5, culmen 38.5, tail 96, weight 63.

Taxonomy: measurements accord with this race.

Notes: Our specimen constitutes the first fully documented specimen taken south of the Himalayas. Abdulali and Hussain (1973) discussed three old records from the Peninsula — from Kolatur North (near Madras), Russelkonda (Gumsur), and the Nilgiris.

830. **Dryocopus javensis hodgsonii** (Jerdon).
INDIAN GREAT BLACK WOODPECKER.

A single adult was closely observed in selectively-logged forest at Jyothimamidi. This is a first record for Andhra Pradesh and the E. Ghats.

845. **Picoides macei macei** (Vieillot).
INDIAN FULVOUSBREASTED WOODPECKER.

Specimens: 1 (male) Pedvalasa, 18 October 1983; 1 male, Lankapakalu, 24 October 1983; 1 (male), 1 female (o.n.e.) Wangasara, 9, 10 March 1985.

Measurements: (males) 100, 101.5, 104, culmen 22, —, 23.5, tail 57.5, 59, 63, weight 34, 35, 39; (female) wing 104.5, culmen 24.5, tail 61.5, weight 35.

Soft parts: (males) iris dark brown, legs dark grey, bill blue-gray with a black tip; (female) iris dark brown, legs dark olive brown, bill black, gape grey.

Notes: The Pedevalasa male showed wing, tail and body moult. This was the common woodpecker of hilly forest.

847. **Picoides mahrattensis mahrattensis** (Latham)
YELLOWFRONTED PIED WOODPECKER.

Specimens: 1 male (t.e.), Jyothimamidi, 1 March 1985.

Measurements: wing 101, culmen 22, tail 57, weight 33.

Soft parts: iris dark tan, legs black, scute interstices washed white, orbital skin purplish brown.

Notes: Our specimen was collected from a flowering Simul tree.

852. **Picoides nanus hardwickii** (Jerdon).
SOUTHERN BROWNCROWNED PYGMY WOODPECKER.

Specimens: 2 females (o.n.e., o.s.e.) 24 October 1983, 8 March 1985.

Measurements: wing 80, 80.5, culmen 14.5, 16, tail 38, 40, 16 (2). Mist-netted: weights [males] 15.5, 16, (female-plumaged) 15.8 (2), 17.5.

Soft parts: iris pale green or greenish ivory, legs brownish black, ocular skin dull lavender, maxilla black, mandible steely grey.

856. **Hemicircus canente** (Lesson).
HEARTSPOTTED WOODPECKER.

Specimens: 1 male (t.n.e.), Jyothimamidi, 28 February 1985.

Measurements: wing 99.5, culmen 22.5, tail 31, weight 40.

Soft parts: iris dark brown, legs slaty-black, foot pads grey, bill black.

Notes: Invariably observed in pairs; very vocal in the early morning. New for the Eastern Ghats.

861. **Chrysocolaptes lucidus guttacristatus** (Tickell).
EASTERN LARGER GOLDENBACKED WOODPECKER.

Specimens: 1 male (testis 13×9 mm), Pedevalasa, 19 October 1983; 1 [male], 1 female, 1 unsexed, Jyothimamidi, 25, 28 February, 2 March 1985.

Measurements: (males) wing 163, 174, culmen 53, 55, tail 87.5, 92, weight —, 185; (female) wing 173, culmen 49, tail 85, weight 125; (unsexed) wing 162, culmen 46, tail 82, weight 163. Mist-netted: male weight 175, [female] weight 182.

Soft parts: (male) iris brownish yellow, legs dirty greyish black, bill black; (female) wing iris cream-pink; (immature) iris dark greenish buff, legs slaty grey, pads of feet yellowish, maxilla black, mandible horn.

(*to be continued*)

THE BUTTERFLIES OF THE NILGIRI MOUNTAINS OF SOUTHERN INDIA (LEPIDOPTERA : RHOPALOCERA)[1]

Torben B. Larsen[2]

[*Continued from Vol. 84*(2): 316]

Satyrinae

MELANITINI

151. **Melanitis leda leda** Drury

The COMMON EVENING BROWN is one of the few truly ubiquitous butterflies and it may be found literally anywhere in the Nilgiris, albeit in very fluctuating numbers. The two seasonal forms are very different indeed (see Brakefield & Larsen 1984 for a discussion on seasonal variation in this and other species). In a place like Delhi with strong and temporally well-defined dry and wet seasons, the wet season form occurs during the wet season and is immediately replaced by a large dry season brood at the end of the monsoon. The camouflaged dry season form seems to carry the entire population through the long dry and cold winter and spring. Because of the great ecological variation in the Nilgiris matters appear less clear cut. From the time I arrived in April till I left in October I nearly only saw dry season specimens which appeared to be quiescent. As time went by they became fewer and fewer as well as increasingly worn. During the wet months of July to September very few were seen and at no time was any mass wet season brood in evidence, though occasional wet season specimens were met with among the few remaining, battered dry season ones. Any hope that I had of a consistent pattern was rudely dissipated, but long term records on the seasonal forms of this butterfly from anywhere in India are still highly desirable. All the Evening Browns are fond of rotting fruits, but they visit flowers only occasionally. I have only once seen large numbers of this species at Lantana during an early morning in Delhi park. The range covers all of Africa, southern Arabia, the Oriental region, the Papuan subregion, and the Pacific as far as the Bismarck Islands. Many remote ocean islands have populations of this butterfly.

152. **Melanitis zitenius gokala** Moore

The GREAT EVENING BROWN is larger than the two other South Indian species, the costa of the forewings is more rounded, and the apical markings of the forewing upperside generally more luxuriant than in *M. leda.* Small dry season specimens may be confused on casual inspection, but hardly in set specimens side by side. I have not found the species at all common in the Nilgiris except on one occasion on the Nadgani Ghat in September 1986, when I saw more than a dozen specimens. Wynter-Blyth reports that it is sometimes common on the Coonoor Ghat and at Kallar where I have not seen it, but his records are from December and January when I was not in the area. The wet season form never has the large underside eye-spots so prominent in *M. leda.* The distribution covers

[1] Accepted January 1987.

[2] Snoghoj alle 29C, 2770 Kastrup, Denmark.

South India, then from Kumaon east to Indo-China and the Greater Sunda Islands.

153. **Melanitis phedima varaha** Moore

The DARK EVENING BROWN is much darker than the other two, so much so that this is enough to tell them apart. The apical eye spots lack the orange of the two other species. It is a somewhat scarce species of lowland forest, there being records from Kallar, Mukkali and various points on the Nadgani Ghat. My field notes show a specimen from near Kotagiri in 1958 but this is exceptional. It may occur in the subtropical forests, and I found it quite common in such a habitat on the Biligiriranga Mountains in August, 1986, even occasionally in moist-deciduous forest. It is very difficult to catch since it usually frequents bamboo thickets. Its habits do not differ much from those of *M. leda,* though I have no records of its coming to light. The distribution covers Sri Lanka, South India, Pachmarhi (in a rather special subspecies where the forewing apex is broadly yellow), and from Jammu east to the Philippines and Sumatra.

ELYMNIINI

154. **Elymnias hypermnestra caudata** Butler

The COMMON PALMFLY is usually rather scarce in the Nilgiris, though occasionally it may be common in late September/October in the plantations at Kallar where it feeds on the coconut and areca palms that are among the main crops. I have also taken it at Kallar in June and small numbers on the Nadgani Ghat at various times. The butterflies do not fly much spontaneously and often have to be beaten out of the palms. Sexual dimorphism is very strong, the female being a very credible mimic of the two common Danaids, *Danaus genutia* and *D. chrysippus.* How credible will only be apparent to those that have actually seen it in nature since the likeness in cabinet specimens is much less. The species is found in Sri Lanka, in South India, then from about Dehra Dun to the Philippines, Borneo and the Lesser Sunda Islands. In the Philippines, Malaysia, Sumatra and Borneo the female is not mimetic and looks like the male.

LETHINI

155. **Lethe europa ragalva** Fruhstorfer

The BAMBOO TREEBROWN is not rare in the Nilgiris though it is somewhat local and unpredictable in occurrence. It is usually found in lowland forest where bamboo abounds, but it will colonise rice growing areas where clumps of bamboo are left. Even when bamboo is present it will not be found in the drier formations such as the Masinagudi area. All the *Lethe* are very wary and difficult to catch, not least just when you want to be certain of the identification of a given specimen. This is a great nuisance since the three species are not identifiable with absolute certainty in the field. Their habits are somewhat skulking in dense bamboo, but they will come to damp patches, rotting fruit and fresh cowpats, though they never lose their shyness. They can also be trapped in traps baited with rotten crab, perhaps the best way of obtaining a good series. Occasionally they are attracted to lights in the late evening. It is absent from Sri Lanka, found in much of India and extending to most of the Oriental region.

156. **Lethe drypetis todara** Moore

I have not found the TAMIL TREEBROWN nearly as common as imputed by Wynter-Blyth, having seen it chiefly in bamboo infested moist-deciduous forest in the Wynaad. It comes freely to foul substances and I have caught five specimens at the same time on fresh leopard droppings. When not engaged in

such pursuits the species is very difficult to get at, the flight being very erratic. I have taken some also on the lower parts of the Nadgani Ghat, and I found it common in moist-deciduous forest in the Biligiriranga Mountains. A specimen taken back to Kotagiri for photography escaped and was immediately snapped up and consumed by my resident White Spotted Fantail Flycatcher (*Rhipidura albicollis*). The species is endemic to Sri Lanka and South India.

157. **Lethe rohria neelgheriensis** Guérin-Méneville

The COMMON TREEBROWN is more of a hill insect than the two other South Indian *Lethe* and it is somewhat weaker on the wing. It shares the habit of coming to various foul substances and sugary material. During my childhood we had a flourishing colony at Spring Cottage in Kotagiri, but during 1986 I found it only in the Biligiriranga Mountains, where it was common in subtropical evergreen and moist-deciduous forest near the Honametti Estate. The range covers Sri Lanka, South India, suitable spots on the Indian peninsula, then east to China and Bali, for some odd reason wholly bypassing Malaysia.

MYCALESINI

The genus **Mycalesis**

The Bushbrowns of the genus *Mycalesis* form a large and difficult complex which is in need of revision. Three of the Nilgiri species are easily identified: *M. anaxias* with its prominent white bar, *M. adolphei* with the thin red ring about the forewing eye-spot, and the little, ever happy looking, *M. patnia*. The remainder are very similar species which can be difficult to identify even with the help of the male genitalia. I had hoped to be able to give a fairly good account of their characteristics and distribution, but in the event I found them rather scarce and have insufficient comparative material. The notes given under each of the species refer to the wet season forms. The dry season form have reduced underside eye-spots and are more variable, thus being even more difficult to identify. Females, especially single specimens, are impossible to be certain of. For the species numbered 159 to 164 it is also likely that the taxonomy will need changing. It is based largely on Evans (1932) and Wynter-Blyth (1944, 1957). I do, however, believe that the number of species is correct. Talbot, FAUNA OF BRITISH INDIA, links the taxa *orcha* and *subdita* as subspecies of *M. visala.* On both morphological and distributional grounds I do not find this an attractive solution.

158. **Mycalesis anaxias anaxias** Hewitson

The WHITE BAR BUSHBROWN is one of the few species that is especially linked to the middle heights subtropical evergreen forests, rarely being found in the tropical zone and only occasionally in the montane forests. I have not found it at all common and neither did Hampson. Wynter-Blyth's optimistic assessment must be based on a few exceptionally vigorous colonies in his immediate area. I have only seen a few specimens on the upper reaches of the Nadgani Ghat, near Devala, in a bit of relict forest near Naduvattam, and at Law's Falls below Coonoor. The species hardly ever emerges from dense forest. It is found in South India and then recurs from Nepal to Indo-China and Malaysia, generally as a montane or submontane species.

159. **Mycalesis perseus typhlus** Fruhstorfer

The COMMON BUSHBROWN male can usually be recognised by the brand on the underside forewing tornus which is very small and black. On the hindwing underside the eye-spot in

space 3 is usually out of line with the others tornal eye-spots, a condition slightly approached in some other species. It is one of the most common Indian species, but I have not seen many in the Nilgiris, having taken a few certain specimens at Kallar and at Nadgani. It shares its habits with the other species, flying mostly in shady, grassy places in wooded country. It may be frustratingly difficult to capture since it often flies inside bushes. The *Mycalesis* hardly ever visit flowers but they will come to rotting fruit. The species is found in Sri Lanka and most of India to at least Malaysia.

160. **Mycalesis mineus polydecta** Cramer

The DARK-BRAND BUSHBROWN in South India is readily recognisable by having a short under forewing brand that is a much lighter brown than the jet black of the preceding species. The remaining four species all have long brands extending to the white discal line. I have definite specimens from the wetter parts only, at Nadgani and Mukkali, but elsewhere it is quite common also in the drier zones. However, Wynter-Blyth also remarks that it seems strangely scarce in the Nilgiris area. The range covers Sri Lanka, most of India, then to the Philippines, Taiwan, Sulawesi and Malaysia.

161. **Mycalesis subdita** Moore

The TAMIL BUSHBROWN is the first of the long branded species and is generally not too hard to distinguish from the others. It tends to be quite large and well marked. It usually has a well-developed ocellus also in space 1 of the forewing underside, connected with that of space 2 as a double ocellus. Other species may have such an ocellus, but it is rarely strongly developed and only in extreme wet season forms. I have found this species common at Kallar but otherwise did not see it. It is endemic to peninsular India.

162. **Mycalesis igilia** Fruhstorfer

The SMALL LONG-BRAND BUSHBROWN is usually easily identified because its under forewing brand is very long, extending clearly beyond the white discal line. As a result the white discal line is often angled towards the tornus at vein 1b. It is often very common indeed in the bamboo jungles of the Nilgiri Wynaad but seems to be found nowhere else in the area. It is a narrowly endemic species to the Wynaad type vegetation in the Nilgiris, Coorg and the area in between. This may indicate that it is specially adapted to the moist-deciduous forest types where monocotyledons are much in evidence. Its specific status is without doubt. *M. mercea* Evans from Pachmarhi is possibly a subspecies of *M. igilia.*

163. **Mycalesis visala visala** Moore

The LONG-BRAND BUSHBROWN has a long brand, which goes beyond the discal line as in the preceding species. It is otherwise very like *M. subdita* above, though the ocellus in space 1 is usually absent and never prominent. Indeed the latter species is often listed as subspecies of *M. visala* but both are South Indian and my impression is that *M. subdita* is a good species. However, I did not catch the present species in the Nilgiris from where it is recorded by previous authors. The two do seem to be sympatric and not to represent seasonal forms of the same species. *M. visala* is found from South and Central India to Indo-China and Malaysia.

164. **Mycalesis khasia orcha** Evans

The PALE-BRAND BUSHBROWN has a long light yellow brand that is lighter than in the otherwise similar *M. subdita.* The brand does not go beyond the white discal line as in the two preceding species. It is another species that seems to be found mainly in the moist-deciduous type of forest. I have not found it

in the Nilgiris but found it plentiful in the Biligiriranga Mountains. It is reputed to be particularly common at the close of the monsoon in the Nilgiri Wynaad. The range covers South India and Assam/Burma, but the taxonomy of the long-branded species of *Mycalesis* needs further work. However, the presence of four long-branded species in southern India seems certain, whatever their ultimate taxonomic destinations.

165. **Mycalesis adolphei** Guérin-Méneville

The RED EYE BUSHBROWN is restricted to the higher levels of the Nilgiris and the area around Coorg. It is rare at Coorg but common in the Nilgiris above 1900 m in the typical montane *sholas.* Seasonal variation is very marked. The dry season form was very common around Kotagiri in April 1986, gradually becoming scarcer. From late August onwards, in a year of bad rains, the wet season form started to appear. I suspect there are only two annual broods as was also suggested by Hampson, though Wynter-Blyth disagrees with this view. Generally it is found only in dense evergreen forest, sometimes playing along forest paths but often fairly passive. South of the Nilgiris the species is replaced by the Red Disc Bushbrown *Mycalesis oculus* Marshall which has the same habits. This situation matches that of *Ypthima chenui* and *Y. ypthimoides.* These two pairs are the only examples of vicariance north and south of the Palghat Gap among butterflies.

166. **Mycalesis patnia junonia** Butler

The GLAD EYE BUSHBROWN is endemic to South India and Sri Lanka where it is often very common in the tropical and subtropical evergreen forest, occasionally being found also in heavy deciduous forests, but very rarely colonising disturbed areas. The flight is low and stumbling and much weaker than the other members of the genus. The *Mycalesis* rarely if ever visit flowers, but some are fond of rotting fruit, and occasionally *M. patnia* can be seen on fallen berries and fruits in large numbers. In October 1986 I saw a specimen passing through my Kotagiri garden at 1900 m in a straight line following the main migration, at the time towards the SW. The nearest locality where I have seen the species is miles away and some 400 m lower, but could it really have been migrant?

167. **Orsotrioena medus mandata** Moore

The NIGGER is a fairly common butterfly in the wetter low-level forests, occasionally being found in drier conditions. In behaviour it is very like the *Mycalesis* and it is, indeed, often found with one or more of these. It differs in having only three major eye spots on the underside. Sometimes the species is abundant at Kallar during the monsoon. The degree of seasonal variation is so strong that I included it in a review of this topic (Brakefield & Larsen 1984). I have only seen wet season forms in the Nilgiris, but Hampson mentions the dry season form from the western slopes. The genus is monobasic and the single species is found from Sri Lanka to Australia.

168. **Zipoetis saitis** Hewitson

The TAMIL CATSEYE is a most interesting butterfly, limited to the wettest lowland forests of the Western Ghats system. Wynter-Blyth's record of a specimen from the lower parts of the Coonoor Ghat is most unusual. Mostly it is found on the western slopes where bamboo is prevalent and most records are from the Nadgani Ghat area. Even here the species is quite rare though this is perhaps in part because of its retiring habits and unwillingness to fly spontaneously. Despite the fact that its unique colour pattern makes it highly conspicuous when on the wing, I have only seen it

six or seven times, never more than two on any given day. I have also seen it once at Mukkali at the approaches to Silent Valley. It comes to fallen fruit and probably systematic 'sugaring' would be the best way of getting a good series. I certainly know from experience that chasing it through dense jungle with a butterfly net is a very poor way of procuring specimens. It is endemic to South India.

YPTHIMINI

169. **Ypthima asterope mahratta** Moore

The COMMON THREERING is decidedly rare in the Nilgiri area though it is far from difficult to identify and often the only member of the genus where found. It is limited to the drier lowland habitats such as thorn forest, but will be found also in the mixed deciduous forest and agricultural land. I am very surprised that Wynter-Blyth should have recorded it from the Nadgani Ghat area and almost certainly it would have been on cleared land. Sometimes it flies with *Ypthima ceylonica.* It is the only one of the genus to be Palaeotropical, occurring from Burma and India (not Sri Lanka) through Arabia to the eastern Mediterranean and much of Africa. Specimens from both Lebanon and Yemen have a haploid chromosome number of n=16 and it would be very interesting to know whether it is the same in India. The common northern species, *Y. inica* is entirely absent.

170. **Ypthima ceylonica** Hewitson

The CEYLON FOURRING is endemic to South India and Sri Lanka where it is often abundant. In the Nilgiris it seems to be exclusively a species of the southern slopes, mainly confined to open forests at low levels, but penetrating the subtropical zone. In autumn of 1957 I found a thriving colony near my school at Kotagiri (1900 m) which must be more exceptional. It is a much more frequent visitor to flowers than are most of the *Ypthima.* At Kallar, where the species is usually very common, a small polygonaceous weed proved particularly attractive in addition to the usual *Tridax.* There is some confusion over the specific status of *Y. ceylonica* and *Y. huebneri,* the modern trend being towards considering the latter to be a subspecies of the former. I cannot agree with such a view. The two are often sympatric on the southern slopes of the Nilgiris without intermediates occurring. I have seen them flying together on a permanent basis at Glenburn, just above Kallar and in several localities in the Biligiriranga Mountains. The apical eye spot of *Y. ceylonica* is consistently larger than that of *Y. huebneri* which species also displays strong seasonal variation that is almost absent in *Y. ceylonica.* Shirozu & Shima (1979) also maintain the two as distinct species.

171. **Ypthima huebneri huebneri** Kirby

The COMMON FOURRING is common mainly in the evergreen forests of the tropical and subtropical zones, but it is also found in the deciduous formations. It often flies with *Ypthima ceylonica* and as argued under that species I have no doubt that they are quite distinct. *Y. huebneri* is much weaker on the wing than *Y. baldus,* a species with which it often shares its habitat. It only rarely visits flowers and never comes to water, fallen fruit or foul substances. It does not occur in Sri Lanka but is found through most of India, extending to Indo-China and Malaysia.

172. **Ypthima avanta striata** Hampson

The Nilgiri form of the JEWEL FOURRING was described by Hampson as a distinct species, later to be combined with *Y. avanta.* It has also been recorded under the specific

name of *Y. lisandra,* but I follow Shirozu & Shima (1979) in accepting the former as a distinct species. The almost uniform dark brown upperside with hardly a trace of apical eye spots on the forewings will serve to distinguish it from the other South Indian members of the genus. Hampson recorded it as common on the southern slopes at 3000 ft in August, December and January. Wynter-Blyth failed to find it, and I have but a single male from the Burnside Estate, 1400 m (29.vi). It certainly does not seem to be common today. The distribution covers Sri Lanka, South and parts of peninsular India to Madhya Pradesh, then from Jammu to Burma, with *Y. lisandra* further east.

173. **Ypthima baldus madrasa** Evans

The COMMON FIVERING is often abundant in the wetter forests of the tropical and subtropical zones, including parts of the mixed deciduous forest. The flight is stronger than that of most members of the genus. It is a more frequent visitor to flowers than is *Y. huebneri* with which it often flies. It often basks in the sun with the wings three-fourths open. It is found through most of India and then east to Japan and Sundaland. Its absence from Sri Lanka is curious.

174. **Ypthima chenui** Guérin-Méneville

The NILGIRI FOURRING is the largest South Indian member of the genus and is characterised by the presence of some marked chestnut bands on the hindwing underside, the outer of which fully encompasses the marginal eye spots. It endemic to the highest mountains north of the Palghat gap, being replaced by *Y. ypthimoides* to the south. Hampson records that both are present in the Annamalai Hills but I have not seen able to verify this. Wynter-Blyth records the species as being common in open country on the plateau proper from February to April, while Hampson said it had four broods on high, rocky brown. From my childhood I remember that it was common at various points near Kotagiri where I never saw it during 1986. On 5.x I finally found it again at Avalanche, mainly where rocks broke through the verdant grass.

175. **Ypthima philomela tabella** Marshall & de Nicéville

The BABY FIVERING is a small species which in the Nilgiri area is wholly limited to the Nilgiri Wynaad where it was reputed to be common by earlier authors. I have entirely failed to find during visits in May, June, July and September. The species is also found in North Burma, and according to Shirozu & Shima (1979) it extends from there to Vietnam, Malaysia, Sumatra, Java, Bali and Sulawesi. Other authors would maintain that the species should be split into several.

AMATHUSIINAE

176. **Discophora lepida lepida** Moore

The SOUTHERN DUFFER is the only South Indian representative of the subfamily Amathusiinae. It is found only in the wettest lowland evergreen forest where bamboo is present and it is rare to very rare, though in part this is due to very retiring habits. Additionally it is only spontaneously on the wing during dawn and dusk, except in the case of ovipositing females. The best way of securing specimens is through baiting with rotten fruit or fermenting toddy. Hampson saw but one on the western slopes, Wynter-Blyth took a few at jaggery bait at Kallar, and I took a fine female at the bottom of Nadgani Ghat which was ovipositing on bamboo on a dull day. It is worth recalling that a fine female was caught about fifty years ago inside the cordite factory at Aravankadu, 1000 m higher and a dozen

kilometres from the nearest suitable habitat. A distinct subspecies flies in Sri Lanka and other members of the genus are found from the Himalaya east to most of the Oriental region.

Nymphainae

Nymphalinae

177. **Byblia ilithyia** Drury

The JOKER is a dry zone butterfly of Afrotropical origin most likely to be found in broken country and along hedgerows on the plains surrounding the Nilgiris but even here it appears to be local. Many years ago I collected a good series somewhere between Gudalur and Gundlupet. The species has some migratory capacity and will sometimes be met with on the plateau. Wynter-Blyth collected a specimen at Ketti (24.ix.1942) and I have one from Kotagiri from September 1955. They probably follow the autumn migrations. The species is found in Sri Lanka, in the drier parts of the Deccan, but not in northwestern India. The African population ranges throughout the drier parts of Africa and in Southwest Arabia as far east as Dhofar. There is no geographical subspeciation within this vast range and a Nilgiri specimen cannot be told from a Nigerian one. This is a classical Sudano-Deccanian distribution pattern.

178. **Ariadne ariadne indica** Moore

The ANGLED CASTOR is not rare and may be found anywhere in the Nilgiris though the following species is usually the more common of the two. It is migratory and this is doubtless one of the reasons for its wide distribution, eclectic choice of habitat, and somewhat unpredictable occurrence. It is often found flying in and out about stands of the larval food plants, especially *Ricinus communis* and species of *Tragia.* Care must be taken with the latter plant which has extremely unpleasant stinging properties. Flowers, sap exudations and sugary substances are also attractive. The genus is found in both Africa and Asia; the species is found practically throughout the Oriental region.

179. **Ariadne merione merione** Cramer

The distribution, ecology and bionomics of the COMMON CASTOR are almost identical with those of *Ariadne ariadne* and the two are often found together at the same time, sharing the same food plant. It would be interesting to study closely what, if any, mechanisms exist to minimise direct competition between them. Apart from *Colotis danae* and *C. eucharis* I cannot offhand recollect any species pair that are so similar in all respects. I have bred the species on *Ricinus* in Delhi. The larvae are very variable and the pupa is trimorphic in green, brown and grey. The range of the species covers most of the Oriental region.

ARGYNNINI

180. **Cupha erymanthis maja** Fruhstorfer

The RUSTIC is a common butterfly in the Nilgiris, being centred on the subtropical evergreen forests and the upper regions of the tropical zone. It is, however, not uncommon in parts of the evergreen tropical zone, in mixed deciduous forest and on the plateau, at least at certain times of the year. The males fly restlessly through the dense forests in search of females. The latter fly deep inside the forest investigating potential food plants with a degree of patience that usually outlasted mine, though I wanted to breed the species whose pupa is reputed to be a thing of great beauty. The few times I saw an egg laid it was on plants that were very small and that I could not identify. Both sexes come to flowers and the male very

occasionally to damp patches. It is found in South India and Sri Lanka, recurring from about Musoorie east to most of the Oriental region.

181. **Phalanta phalantha phalantha** Drury (*Atella phalantha*)

The LEOPARD BUTTERFLY is fairly common in the Nilgiris, but unpredictable in timing, frequency and distribution, probably at least in part because it is a strongly migratory species. From time to time it may be met with anywhere from the Bhavanisagar subdesert to the Nadgani rainforests and from the foot of the Ghats to the highest peaks. The species is very fond of flowers and on 9.vi.1986 I saw hundreds at damp patches along a small river near Masinagudi. Relatively small numbers participated in both the May and October migrations of 1986. In the subtropical forests around Glenburn the larval food plant was a *Salix* that grew along river beds. The range covers the whole of Africa, southwestern Arabia and the entire Oriental region.

182. **Cirrochroa thais thais** Fabricius

The TAMIL YEOMAN is endemic to South India and Sri Lanka but is closely related to a number of Oriental species in the genus. It is a common butterfly in all types of evergreen forest and on the plateau it is often seen wandering across agricultural lands in a somewhat haphazard manner. My childhood field notes from 1958 say that 'it seems to be migrating in spring', but I did not see directional movements of the species in 1986. Often large numbers are found flying in and out of a low forest tree, presumably the larval food plant, often settling on the underside of leaves. Both sexes come readily to flowers, the males occasionally to water. The wings are very delicate and often break in the net which is also the case in *Cupha erymanthis.*

183. **Vindula erota saloma** Swinhoe (*Cynthia erota*)

The magnificent CRUISER is not rare in evergreen forests at low and middle levels. The golden orange of the male and the copper sheen of the female are both splendid in their own way. Males often bask at a vantage point from which they make brief sorties. At such times the only way to catch them is with a very long handled net. However, they often visit Lantana in the early mornings and are then easily netted. They visit damp patches occasionally and may be caught on carnivore droppings, especially those of the otter. Gordon Thompson had one coming in a trap baited with rotten crab at Nadgani, unusual, I think, among the *Argynnis* group. The Cruiser occurs in Sri Lanka and South India, then from Nepal east to Malaysia, Borneo, Sulawesi and Sundaland. Other species of the genus occur in New Guinea and the remainder of the Oriental region, some overlapping with the present species.

184. **Argyreus hyperbius hybrida** Evans (*Argynnis hyperbius*)

The INDIAN FRITILLARY is a Palaearctic butterfly that has managed to colonise the montane zones of Ethiopia, South India, Sri Lanka, Malaysia, Sumatra, Sulawesi (Vane-Wright, *pers. comm.*), and New Guinea. This feat is quite unique in the butterfly world but it is reminiscent of several genera of plants (e.g. *Impatiens*). Possibly the wide range is due to the migratory capacity of the species which may breed on the plains of India during winter. I have seen large numbers on the Chambal river south of Agra in December 1986, several hundred kilometres from any permanent foothold. In the Nilgiris the species is confined to the plateau proper mainly on moist grassland and in clearings in *sholas.* It is quite common and on the wing throughout

the year. The Nilgiri population is sedentary to the extent that even strays from the plateau are never met with at lower levels. It comes freely to flowers and I have seen one male on the excrement of a dog. In flight the female is a very respectable mimic of *Danaus genutia.* I saw many attacks on males at Longwood Shola near Kotagiri by the Bulbul (*Pycnonotus jocosus*), but whether it was by chance or design that the female was not attacked cannot be said for sure. Many severed male wings were found in the area. Three caged females in Kotagiri laid freely on the leaves of two species of violet in contrast to the European Argynnids which lay on nearby inanimate objects. This difference is doubtless mediated by the fact that *A. hyperbius* is continuous brooded whereas the egg of European Argynnids represents the hibernation stage. The egg stages lasted nine days, the larval stage forty days, and the pupal stage sixteen days. Woodhouse (1952) reports quite similar data from Sri Lanka. In all 45 males and 41 females emerged successfully, indicating a normal sex ratio. The males hatch on average three days before the females, a very moderate level of protandry.

HELICONIINI

185. **Cethosia nietneri mahratta** Felder

The TAMIL LACEWING is a lovely butterfly of the wettest lowland forests of the Western Ghats system where it may be quite common. A darker subspecies occurs on Sri Lanka which appears to be ecologically somewhat more tolerant, a trait that is found in other rainforest species as well. On the wing the lacewing is virtually indistinguishable from the toxic *Danaus genutia.* They appear to be in a co-mimicry relationship, though I am not certain that the *Cethosia* have yet conclusively been proven toxic. However the larval food plants of the Passifloraceae are exploited by toxic Ithomiines in the Neotropics and by Acraeines in Africa, and when handled *Cethosia* feigns death, a trait usually associated with protected species. Caged females at Kotagiri refused to lay eggs on two different Passifloraceous plants.

NYMPHALINI

186. **Junonia hierta hierta** Fabricius
(*Precis hierta*)

The YELLOW PANSY is the first of a series of common species with pretty colours which are among the most widely distributed and noticeable of all the Indian butterflies. The Yellow Pansy is a common butterfly whose main habitat is open scrubland and ill-kept agricultural land, but it may also be found in mountainous districts, and on occasion may be taken practically anywhere in the Nilgiris. Numbers fluctuate considerably. The males are territorial and will select a small stone as a vantage point from where they vigorously chase off all comers. The species, like most of the Pansies, is migratory. It is a Palaeotropical species being found in Thailand, Burma, India and Pakistan, recurring in the rather different ssp. *cebrene* in southern Arabia and throughout dry tropical Africa, with a weak incursion into the eastern Mediterranean (Larsen 1986b).

187. **Junonia orithya swinhoei** Butler
(*Precis orithya*)

The BLUE PANSY is another common plains butterfly that may be found in the Nilgiris in fluctuating numbers, being least common in densely forested areas. This species, too, is migratory although only very small numbers participated in the 1986 migrations in the Nilgiris. I have rarely found it common except

in the thorn forests surrounding the mountains. The distribution is Palaeotropical covering the Papuan subregion, most of the Oriental region, Arabia and all of Africa, occasionally being found as far north as Jordan (Larsen 1986b). It is notable that the species occurs in fairly well-defined subspecies indicating that migration takes place within and not between the subspecific entities.

188. **Junonia lemonias** Linné
(*Precis lemonias*)

The LEMON PANSY is the most common of the five *Junonia* in the Nilgiris, being found practically anywhere in larger numbers than the others, but like them being scarcer on the plateau. It was the most numerous member of the spring migration observed in May 1986 with more than one million specimens (Larsen 1987b), a third of the total number of migrants. The species is a more frequent visitor to damp patches than the others of the genus. The seasonal forms are very marked, but I have not seen any very pronounced dry season forms in the Nilgiris. The species is centred on the Indian subcontinent extending to Malaysia in the east.

189. **Junonia almana almana** Linné
(*Precis almana*)

The PEACOCK PANSY is another common butterfly found all over the plains with the other Pansies, but it is rather scarce in the Nilgiris. I have only seen the wet season form in the area and the dry season form seems to be very rare in Sri Lanka, even in the dry northeast of the country. In Delhi the two forms appear with the seasons like clockwork and hardly overlap in time. It is often found in clearings in the rainforest zone where the Yellow and Blue Pansies do not occur, possibly because they use *Mimosa pudica* as a larval food plant. The range covers most of the Oriental region.

190. **Junonia atlites atlites** Linné
(*Precis atlites*)

The GREY PANSY is the scarcest of the genus, being linked to more mesic habitats than the others, and usually not common, though I have sometimes seen fair numbers at the foot of the Nadgani Ghat. It occurs occasionally at Kallar. Some time in 1957 I saw a single specimen following the main migration in Kotagiri (1900 m), but this is exceptional and it is essentially a low-land species. Most of my specimens, contrary to the other *Junonia*, have been dry season forms, wet season forms at Nadgani appearing only by August. The distribution covers the entire Oriental region except for the driest parts.

191. **Precis iphita pluvialis** Fruhstorfer

The CHOCOLATE PANSY is very common in wooded country at low and medium heights, becoming scarcer in the driest habitats and the plateau, but nearly as eclectic as the four common *Junonia*. It is an avid visitor to flowers and occasionally to damp patches. This butterfly is a great nuisance to the collector since on the wing it often looks like a better and more interesting insect than it actually is. Like the *Junonia* it is migratory. The distribution covers practically the entire Oriental region.

192. **Vanessa cardui cardui** Linné

The PAINTED LADY is by any yardstick the world's most widely distributed butterfly and probably among the best known. It is also one of the most accomplished migrants, a migrant stream from Mexico to the United States once being estimated at three billion specimens. In the Nilgiris it may be found anywhere, but rarely in very large numbers, and not at any

time of the year, as is so often the case with migrant species. Hampson considered it to be limited to the plateau, but that is not so, and I have seen it at both Mettupalayam and in the Mudumalai sanctuary. Wynter-Blyth considered it to be common on the plateau, but this is only occasionally so. The distribution is practically speaking world wide, though it is missing from the equatorial rainforests and much of Latin America.

193. **Vanessa indica pholoe** Fruhstorfer

The INDIAN RED ADMIRAL is a Palaearctic element that maintains a toehold in the higher mountains of South India. In the Nilgiris it is essentially a plateau species, but occasionally it descends to the subtropical zone. It is mainly found on the edges of forest, but it may also be found in garden areas. It is fairly common but numbers have suffered from the extensive tea planting which has reduced the amount of nettles, its larval food plant. The larvae live singly in little tents spun from the leaves of the nettles, after the mid-rib has been bitten half through. In this, and for that matter all other traits, the species is very similar to the European counterpart (*Vanessa atalanta* Linné). The range covers the Sri Lankan and South Indian mountains, then from the Himalaya east to Japan and for some very odd reason the Canary Islands.

194. **Kaniska canace viridis** Evans (*Vanessa canace*)

The BLUE ADMIRAL is a handsome butterfly that, at the moment at least, is relatively scarce on the plateau of the Nilgiris and occasional in the subtropical forests. I am quite certain that the species was much more common during my childhood (1954-1958) and that this is not only because some of the natural habitat has given way to tea. During my six months in 1986 I have seen no more than three dozen or so. It is essentially a butterfly of the clearings and edges of typical *sholas,* but the larval food plant, *Smilax,* was also common in ill-tended plantations. Such habitats used to be widespread but have now given way for tea. Males are very territorial, occupying the same perch for days on end, and continue battles with any intruders even when they have reached the point where they can hardly fly. The range covers the mountains of Sri Lanka and southern India, then from the Himalayas east through temperate Asia, with isolated populations in montane Malaysia and Sumatra.

195. **Hypolimnas misippus** Linné

The COMMON OF DANAID EGGFLY is generally a common butterfly in India, but it is not normally abundant in the Nilgiris. In fact, the next species is usually the more common of the two Eggflies. It represents one of the classical cases of female limited mimicry with the normal female form being an excellent mimic of the toxic *Danaus chrysippus.* The model has two additional female forms, both of which are exceedingly rare in southern India. In the Eggfly the female form *inaria,* which lacks the black and white apex to the forewings, is seen very occasionally. I shot one off a tall eucalyptus with an air-gun in 1957, and I saw another at Kallar in June 1986. The form with white hindwings, *alcippoides,* is even scarcer and indeed I have never seen a fully developed specimen from South India, though doubtless they do occur. Pierre (1980) uses the presence of these forms to dispute the entire concept of mimicry since they are 'inappropriate' mimics, having no models. Their rarity is therefore of great import, because it is rather a powerful argument in favour of balanced polymorphism where the monomorphic model has ensured that selection has almost eliminated the expression of the two rarer forms, both of which are common in Africa. The range

covers the entire new world tropics, with some penetration of the Palaearctic. It has established itself in the Caribbean and parts of Latin America during the 18th and 19th centuries.

196. **Hyplolimnas bolina jacintha** Drury

The GREAT EGGFLY is not rare at low and middle heights in the Nilgiris and may be found intermittently on the plateau. Like other migratory species it is, however, both fluctuating in numbers and somewhat unpredictable. For a period in September 1986 it was one of the most common butterflies in the area and it formed a fair proportion of the large autumn migrations in October. In a reversal of the normal situation this species is actually more common in the Nilgiris than *H. misippus.* The female is mimic of the *Euploea*-species and though the mimicry does not look that impressive in cabinet specimens it is sometimes startlingly effective in nature. There is a long history of all-female broods in this butterfly, shown by Clarke & Sheppard (1975) to be due to early male-limited mortality, and in 1961 this occurred in Delhi. During 1984-1986 in Delhi and during 1986 in the Nilgiris the sex ratios were normal. The distribution covers the entire Oriental region and many Pacific islands, but contrary to *H. misippus* distinct subspecies occur.

197. **Doleschallia bisaltide malabarica** Fruhstorfer

The AUTUMN LEAF is closely related to the *Kallima* and have much the same habits, though linked to the wetter type of evergreen formations. It is generally a rare butterfly in Sri Lanka and South India and must rate as very rare in the Nilgiris. Yates (1935) records it on the basis of specimens collected by Stokes Roberts, and Gordon Thompson feels quite sure he has seen it on one or two occasions in the Nadgani area. I am surprised to learn that it has been found also in the Palnis (Shembaganur), Rodericks & Ugarte (1960) but the locality is probably more mesic than most parts of that mountain range. The distribution covers Sri Lanka and South India, then from Nepal east to practically the entire Oriental region.

198. **Kallima horsfieldi** Kollar (*Kallima philarchus*)

The SOUTH INDIAN BLUE OAKLEAF has often been considered a subspecies of the Sri Lankan *Kallima philarchus* Westwood, and which approach to take is a finely balanced choice, but, actually, not a matter of great consequence. The beautiful leaf shape of the *Kallima* is one of the celebrated examples of camouflage and the South Indian species is as fine as any other in this respect. When settling on branches and tree trunks the *Kallima* invariably settle head down. The species is relatively rare in the Nilgiris and largely limited to evergreen forest at the tropical and subtropical levels, though it may also be met with in the mixed deciduous forest and on occasion in moist-deciduous forest in the Wynaad. In 1957 we saw a specimen at Kotagiri (1900 m) for the first and only time. Despite the enthusiastic pursuit by nearly a dozen kids with nets it managed to escape, and indeed it nearly always does, except when collected at rotting fruit. In nature the species lives a fairly retiring life, only being spontaneously on the wing for a brief period just after noon. Occasional specimens may be seen basking in the early morning sunshine. When disturbed they fly fast but not usually for long, settling among branches and leaf debris where their underside pattern is to their best advantage. The species is endemic to the Western Ghats system, but very similar species are found in Sri Lanka, and then from Sikkim to much of the Oriental

region. I have collected *K. spiridiva* Grose Smith in Sumatra and its characteristics and behaviour in the field did not differ from the South Indian species.

MARPESIINI

199. **Cyrestis thyodamas indica** Evans

The MAP BUTTERFLY is a delightful species with its delicate markings on a semi-transparent background, but it is not a common butterfly in the Nilgiris. In my experience its headquarters is the evergreen forest of the subtropical level, though it is also found in plateau *sholas* and in the tropical evergreen forests. It very rarely ventures into open country. The slow flight with the wings held horizontal for long periods is very characteristic, as is the resting posture with the wings held flat against the under surface of a large leaf. It is fond of coming to water along running streams but is less of a visitor to flowers. I did not come across it often in the Nilgiris and then mainly in the subtropical forests around Glenburn. A few were seen on the Nadgani Ghat and there was a small, but definitely resident, population in the Longwood Shola at 2000 m near Kotagiri. Holloway (1973) gives an interesting review of this genus, with *C. thyodamas* being found in suitable places on the Western Ghats, but not in Sri Lanka, and then again from Jammu east to Burma and Thailand. The genus has a single Afrotropical representative on the mainland as well as one on Madagascar.

LIMENITIDINI

200. **Neptis jumbah jumbah** Moore

Most details of the *Neptis* are taken from the monograph on the Oriental species by Eliot (1969). The CHESTNUT STREAKED SAILOR is endemic to peninsular India and Burma, as well as Sri Lanka. The South Indian form actually approaches that of Sri Lanka, ssp. *nalanda* Fruhstorfer. It is the most common of the South Indian *Neptis* after the ubiquitous *N. hylas* and is generally not rare, and sometimes locally common. It is mainly limited to low-level forest of the mixed deciduous and evergreen types, but it will also penetrate much of the subtropical zone. The flight is rather higher and more powerful than that of *Neptis hylas,* and the species is quite wary when descending to feed on flowers or to seek damp patches. It is rarely seen away from forest. The range is curious inasmuch as it is not found in the Himalaya west of Sikkim despite being present many places in the Eastern Ghats and Bengal.

201. **Neptis hylas varmona** Moore

The COMMON SAILOR is almost ubiquitous in the Nilgiris though it is missing in the driest thorn forest formations. It is often common and would probably be on a list of the twelve butterflies most frequently encountered in the area. It is quite variable in both size and markings and it is sometimes difficult to avoid the impression that more than one specific taxon is hidden within. It is a frequent visitor to flowers and occasionally comes to water, but does not participate in the larger joint mudd-puddling exercises. The range covers most of the Oriental region with the exception of the Philippines and Sulawesi where very similar species occur. It penetrates the Palaearctic region in East Asia.

202. **Neptis clinia kallaura** Moore
(not included in W-B)

While the two previous species are easily identified the three following species are easily confused. Their taxonomy and nomenclature were worked out by Eliot (1969) who should be consulted. This unfortunately means that all old records of the three species *N. clinia,*

N. nata and *N. soma* must be treated with considerable caution. I have not seen certain specimens from the Nilgiris but Eliot mentions both Travancore and Coorg and it is certain to occur. The range covers South India, then from Nepal east to southern China and Sundaland, but not Sulawesi and the Philippines.

203. **Neptis nata hampsoni** Moore
(*Neptis nandina*)

The CLEAR SAILOR is a large and rather scarce species that is found in small numbers in all of the evergreen forests including the plateau *sholas*. I have taken it at Longwood Shola near Kotagiri and on the Nadgani Ghat. Wynter-Blyth found it only near the Runnymede railway station. It tends to fly higher than *N. hylas* and is not always easily caught. The range stretches from South India through wooded parts of the peninsula to Madhya Pradesh, then from Sikkim east to most of the Oriental region.

204. **Neptis soma palnica** Eliot

The SULLIED SAILOR is characterised by the very narrow white bands, more narrow than those of any other South Indian *Neptis*, so much so that older records of this species are likely to be correct. It seems to be very rare in the Nilgiris and I never came across it although the few records are from the Nadgani area. The range covers the wetter parts of the Western Ghats, the Himalaya from Jammu east to Indo-China, South China and Malaysia, but not Sundaland proper.

205. **Neptis viraja kanara** Evans

The YELLOWJACK SAILOR looks very much like the common *Pantoporia hordonia* but is almost twice as large. On the wing it might just be confused with the yellow female of *Athyma nefte*. It seems to be exceptionally rare in the Nilgiris with three or four records from the Nadgani Ghat and the western slopes. I never came across it. It is reputed to be stronger on the wing than the other *Neptis*. Apart from in South India the species occurs from Kumaon to Burma, Thailand, the Andamans and Orissa.

206. **Neptis columella nilgirica** Moore

The SHORT BANDED SAILOR is often placed in its own genus, *Phaedyma*, but I prefer to consider it a subgenus of the *Neptis*. It is another scarce Nilgiri butterfly that I did not come across. Hampson records it from the western slopes, while Wynter-Blyth saw it near Ketti and once on the Mettupalayam Ghat at lower altitude. It seems to be linked to evergreen forests. Apart from in the Western Ghats the species may be found in suitable places on the Indian peninsula, then from Kumaon east to the Philippines and Lesser Sunda Islands, but not Sulawesi. It is strange that only two of the *Neptis* should be found on Sri Lanka as well.

207. **Pantoporia hordonia hordonia** Stoll
(*Neptis hordonia*)

The COMMON LASCAR is a common butterfly in forest at low and middle heights, often flying with *Neptis hylas* around thickets containing *Acacia horrida*. The flight is quite weak and the insect often comes to flowers, but only occasionally to damp patches. There is a slightly darker species with a more prominent speculum on the upper hindwing costa in the form of *Pantoporia sandaka davidsoni* Eliot but I have not been able to trace any certain Nilgiri records. The Common Lascar is found in South India, then from Kumaon east to practically throughout the Oriental region.

208. **Athyma nefte inara** Doubleday
(*Pantoporia nefte*)

The COLOUR SERGEANT is a powerful butterfly with a remarkable degree of sexual dimorphism. The male is black with a white band and a few orange markings, while the female is dark brown with a series of deep orange bands, superficially resembling a large yellow *Neptis*. It is not a common butterfly in South India and seems to be limited to the low-land evergreen forests with slight penetration of the subtropical zone. Most Nilgiri records are from the Nadgani Ghat area, where I have also taken both sexes at Lantana. I have a female also from Mukkali, near the Silent Valley approach road. The males come to water occasionally. The Western Ghats population is isolated, the main range being from Nepal to South China and Sundaland. All four South Indian *Athyma* are absent from Sri Lanka.

209. **Athyma selenophora kanara** Evans
(*Pantoporia selenophora*)

The STAFF SEGEANT male is very like that of the preceding species but lacks white markings in the cell; the female looks like a giant white *Neptis*. Like all the local *Athyma* they both have the white saddle linking the light band of the two hindwings across the thorax and abdomen. It is very rare in the Nilgiris. Wynter-Blyth found a small colony at Wenlock Bridge and in 1957 I collected a single female either at Kodanad or in the Longwood Shola near Kotagiri, but the details escape me now. I did not see it in the Nilgiris during 1986, but I did get a fine female at the very summit of the Biligiriranga Mountains above Honametti Estate. It appears to be centred on the subtropical evergreen zone with ability to colonise also the upland *sholas*. In addition to South India it is found in southern Bihar, and then from Simla east to South China, Borneo and Java. Generally the species is not common.

210. **Athyma ranga karwara** Fruhstorfer
(*Pantoporia ranga*)

In addition to being a distinctive species in other respects the BLACKVEIN SERGEANT may be immediately recognised through its white-dotted abdomen. As with the other *Athyma* it is a scarce butterfly in the Nilgiris. It is strictly limited to well-developed evergreen forest of the tropical and subtropical types. Wynter-Blyth found it in one valley near Runnymede several years running. I have taken two at practically the same little damp patch in the forests below Glenburn (5.v & 12.vi), and Sid Imber saw one near Kunjapannai not far from Glenburn (1.x.1986). There are also a number of records from the Nadgani Ghat where I have twice taken it (21.vi & 4.vii). Apart from in South India it is found from Nepal east to Indo-China and Malaysia and is nowhere common.

211. **Athyma perius perius** Linné
(*Pantoporia perius*)

The COMMON SERGEANT is the most wide-spread and numerous of the genus in the Nilgiris, but it is far from common. There are records from the western slopes, Nadgani, Devala, Kallar, Ketti and Kotagiri. I bred a specimen from an euphorbiaceous plant in the late 1950ies in Kotagiri. The flight is powerful but not normally as high as in the other three *Athyma*. Flowers are visited and occasionally also damp patches. It is found in southern and peninsular India where conditions permit and will be found under more open conditions than the other three. The main range is from Simla east to Taiwan and south to Sundaland.

212. **Moduza procris undifragus** Fruhstorfer
(*Limenitis procris*)

The COMMANDER is not rare in the wettest low-land forests and may occasionally be quite numerous at the foot of the Nadgani Ghat.

Hampson considered it rare and Wynter-Blyth did not meet with it, but during June to August 1986 we found many at Lantana in the Nadgani Ghat area, especially before 11.30 in the morning. Later in the day males would perch and pounce on other passing butterflies high up in the trees. Occasional specimens would come to water. I have seen one or two also in subtropical evergreen forest near Glenburn. It is a most elegant and powerful butterfly, wary when at rest, and it is quite unforgiving towards a clumsy entomologist. In peninsular India and on Sri Lanka it is reputed to occur in various types of deciduous forest under much more xeric conditions than any of the Nilgiri localities. It is found from the level of Dehra Dun in the Himalayas east to practically the entire Oriental region.

PARTHENINI

213. **Parthenos sylvia virens** Moore

The CLIPPER is a large butterfly that is among the most beautiful of all butterflies, the beauty being topped off by a very graceful behaviour. The powerful, gliding flight with the wings held stiff just below horizontal is a delight to watch. The habitat is almost exclusively the wetter low-land evergreen forests of the western slopes. Wynter-Blyth once saw a specimen at Kallar, possibly originating from the Attapadi/Silent Valley area where the species is common. At the foot of the Nadgani Ghat large numbers sometimes come to Lantana in the mornings and they are then very easy to catch, but they never seem to come to damp patches or to malodorous substances. When not attracted to flowers they usually stay in the canopy, perching on a broad leaf from where they make short sorties, but usually staying quite out of reach. Damaged specimens are very often met with. I have seen one flying, awkwardly, with less than one tenth of the right forewing remaining. The species is found in Sri Lanka, South India, in parts of the Eastern Ghats, and then again from about Mussoorie east to the entire Oriental region and New Guinea. There are many subspecies, often quite distinctive.

EUTHALIINI

214. **Tanaecia lepidea miyana** Fruhstorfer
(*Euthalia lepidea*)

The GREY COUNT is a distinctive butterfly that is generally rare in the Nilgiris, though sometimes not rare in suitable localities in Kanara. It is almost exclusively found in the wettest low-land evergreen forests, though occasional specimens have been seen at Kallar. I have seen one or two on most of my visits to the Nadgani Ghat. Specimens in good condition are almost impossible to obtain except on bait or naturally decomposing fruit. Flowers are not visited, damp patches only rarely. The butterfly is fond of sunning itself on a leaf with the wings held flat, but under such circumstances it is very wary. It is found in South India, locally on the Eastern Ghats and more generally from Kumaon to Malaysia.

215. **Euthalia telchinia** Ménétries

The BLUE BARON is not dissimilar to the preceding species, but the wings are more angular and the marginal band of the male is blue instead of grey. According to Wynter-Blyth one South Indian specimen, from Coorg, is all that is known, but according to Harish Gaonkar (*pers. comm.*) more have been seen. Gordon Thompson described to me, in such a way as to be quite certain that no mistake could be involved, how he and his father in the 1960ies had found a small colony of this species in some swamp jungle on the Nilgiri Wynaad. I am almost certain that I saw a male on the Gersoppa Ghat in Kanara in October 1986. It would be most interesting to get a good series of this butterfly since there

is a very good chance that it represents a distinct, unnamed subspecies. Apart from South India the range covers the area between Sikkim and Burma and the species is considered rare throughout its range.

216. **Euthalia aconthea meridionalis** Fruhstorfer
(*Euthalia garuda*)

The COMMON BARON is the most widely distributed and common of the *Euthalia*-group in peninsular India, feeding on mango and cashew as well as other plants. It is sometimes very common in places like Bangalore and I found it plentiful at Goa in October 1986. It is therefore curious that it should be rare in the Nilgiris where in the course of my seven months I have seen less than a dozen in all low-land types of habitat except for thorn forest. This is despite the fact that mango and cashew are extensively planted in the area. It is very fond of fallen fruit and will occasionally come to water, otherwise it is very difficult to bag. The distribution stretches from Sri Lanka and India east to Borneo and most of Sundaland.

217. **Euthalia lubentina arasada** Fruhstorfer

The GAUDY BARON is one of the true jewels among the Nilgiri butterflies, but it is, unfortunately, just as rare as the other members of the genus. I have seen only about half a dozen at Nadgani, Glenburn and Kallar, mainly in evergreen forest, but occasionally in mixed deciduous. During my childhood the species was a genuine, though very infrequent, member of the migratory stream (Larsen 1978). Its habits are those of the genus except that it moves about more freely in direct sunshine. It is found in suitable localities throughout Sri Lanka and peninsular India, extending east to Malaysia. In the remainder of the Oriental region it is replaced by a group of very similar species.

218. **Euthalia evelina laudabilis** Swinhoe

The REDSPOT DUKE is a lovely green butterfly that may be found in evergreen forest at low and medium heights. Some females are very large. It is sometimes placed in a genus of its own, *Dophla.* Though far from common it is the member of the genus that is most frequently met with. Yates, writing on Coorg, said that he was reminded by it of 'a green thought in a green shade'. This green species is, in fact, often met with basking on a green leaf in a tight shaft of sunlight deep in the shade of evergreen forest, and usually it is much to cunning to let itself be captured. At the risk of being anthropomorphic my impression is that it has figured out a collector's strategy long before the collector can begin carrying it out. It is very difficult to get a specimen unless it comes to rotting fruit, and even then it is very wary. The Sri Lankan and South Indian populations are disjunct from the main distribution area which covers most of the Oriental region from Assam east.

219. **Symphaedra nais** Forster
(*Euthalia nais*)

The RED BARON is a most distinctive relative of the *Euthalia* in which genus it is sometimes included. The brick red ground colour, though, is very different from the normal pattern of that genus, and the behaviour is more like that of the *Junonia* than the *Euthalia.* However, the larva has the unmistakable form of the *Euthalia* with the long filaments on each segment lying flat against the leaf. It seems surprisingly scarce in the Nilgiris. Wynter-Blyth saw a few at Kallar and I have seen it three times at the same point on the Kotagiri Ghat in bamboo jungle. During my childhood the

species was a regular, though rare, member of the main migrations (Larsen 1978). The species comes avidly to both fruit and water. Its rarity in the Nilgiris is puzzling. It is sometimes very common on Chamundi Hill near Mysore. I have seen it in large numbers near Mhow, and in October 1986 it was very common in the Gir Lion Reserve in Saurashtra. The species is endemic to Sri Lanka and the Indian subcontinent and seems to be found mainly in various deciduous forest formations that are much less mesic than the normal habitat for *Euthalia* species.

APATURINAE

220. **Rohana parisatis atacinus** Fruhstorfer (*Apatura parisatis*)

The BLACK PRINCE is one of two South Indian representatives of the Apaturinae, a subfamily that is best developed on the frontiers between the Oriental and eastern Palaearctic. The species is rather rare in the Nilgiris, mainly found in the subtropical evergreen forests. The female is very much like a member of the genus *Ariadne* but the small black male is unmistakable. My only Nilgiri specimens are from 1957 when I collected a pair at the edge of a *shola* at Kodanad while on a scout camping trip. Hampson also considered it to be rare. The distribution covers Sri Lanka and South India, then from Kumaon east to Sundaland and the Philippines.

221. **Euripus consimilis meridionalis** Wood-Mason

The PAINTED COURTESAN is very rare in the Nilgiris. Hampson took one on Lantana in the NW corner of the Nilgiris, Wynter-Blyth secured one at Kallar and saw one more, I took one female in the forest below Glenburn (12.vi). There are some other Nilgiri specimens, including a pair from the Droog taken by Meinertzhagen in 1890 now in the British Museum (Natural History). I have also seen a recent Nadgani specimen in a photograph of a Japanese collection. The species would thus appear to be limited to evergreen forest of the tropical and subtropical types and to be generally rare. It is, in fact, so rare that it is difficult to understand how viable populations are maintained, since it is a large and highly characteristic butterfly that comes to rotting fruit and apparently to flowers, though flowers are not visited by the European Apaturinae. The species in the genus are generally considered to be mimetic, and some Malaysian species are splendid mimics of Danaids. The female of the South Indian species is a mimic of the day flying Zygaenid moth *Cyclosia papilionaris australinda* Hampson (kindly determined by G. Tarmann of the Tiroler Landesmuseum in Austria). The species is found on the Western Ghats and then from Garhwal east to Burma and Thailand.

CHARAXINAE

222. **Polyura athamas athamas** Drury (*Eriboea athamas*)

The COMMON NAWAB is the most ecologically eclectic and widely distributed member of the Oriental Charaxinae, and so it is in the Nilgiris where the species can be caught almost anywhere in the low-land and middle levels. It is, though, not much at home away from forest. In 1958 there was a resident colony on one or two trees at 1900 m near Kotagiri according to P. Tousgaard, but this is exceptional. The males often perch on leaves fairly high up at the edge of a bit of forest from where they make furious sorties to investigate any passing butterflies, but otherwise they are mainly seen when coming to malo-

dorous substances or to water. Sometimes a whole string of specimens can be caught at the same little patch of otter droppings in the course of a morning. The females are very rarely met with. The species is found in Sri Lanka, much of India, and most of the Oriental region. The genus has recently been subject of an excellent monograph by Smiles (1982).

223. **Polyura agraria agraria** Swinhoe
(not mentioned by W-B)

The ANOMALOUS COMMON NAWAB (it does not have a current english name) is a smaller and paler butterfly with more acute forewings and relatively broader light bands on the forewings. When I first saw two specimens from Kallar I was in no doubt that it was a distinct species even though I knew nothing of its taxonomic status — indeed I hoped it might be new. The species has been the subject of much discussion and has usually been considered a form of *P. athamas,* but I am surprised that it was only finally raised to specific rank by Smiles (1982). The species seems to be very rare in the Nilgiris and I have only three from Kallar where I have seen well over a hundred of the Common Nawab. From the rest of the Nilgiris I must have seen specimens or pictures of an additional hundred or more; none was the present species. Its range covers most of the Oriental region and in some localities the two species are more difficult to tell apart than they are in the Nilgiris. It is, however, absent from Sri Lanka where *P. athamas* is common.

224. **Polyura schreiber wardii** Moore
(*Eriboea schreiberi*)

The BLUE NAWAB is a superb butterfly that is much prized by collectors and which on the whole is rare to very rare in the wettest parts of the Western Ghats system, including the western slopes of the Nilgiris. I have seen it on two occasions at the foot of the Nadgani Ghat. Specimens are very difficult to get at except when they come to baits or traps. I saw a perfect male on monkey droppings at Sholayar in the Annamalai mountains. Usually both sexes keep very high in the canopy, occasionally swooping down in the most erratic manner to identify the source of some odour, and then usually zooming back up without settling. In Kanara I have on one occasion seen a female investigate potential food plants some distance from the nearest forest, but this was in a recently clear felled area and may have been exceptional. The range covers South India's wettest parts, then from Assam to Malaysia. It is everywhere considered rare.

225. **Charaxes bernardus imna** Butler
(*Charaxes polyxena*)

The TAWNY RAJAH is one of the most powerful and impressive insects in South India and the sight of a large female flying at maximum speed is a true delight. The top speed exceeds sixty kilometres an hour. It is, unfortunately, a rare species in the Nilgiris and even when found is very difficult to catch unless at natural or artificial baits. Rotten organic matter, especially crabs, will attract the male, both sexes coming to fermenting fruit on occasion. The male sometimes perches well out of reach, attacking all passing butterflies, occasionally coming within range of the net. I know of Nilgiris specimens only from various points on the Nadgani Ghat and at Kallar and it seems to be limited to lowland evergreen forests. In Sri Lanka it goes higher up the hills and elwhere in India it is found under less mesic conditions than in the Nilgiris. In addition to Sri Lanka and South India it is found from about Mussoorie to South China, Sundaland, the Papuan subregion and the Bismarcks. Some authors subdivide the taxon

bernardus into several closely related species, giving *imna* specific status.

226. **Charaxes solon solon** Fabricius (*Charaxes fabius*)

The BLACK RAJAH is an unmistakable butterfly looking very much like some of the Afrotropical *Charaxes*. The name *fabius* Fabricius is older but preoccupied, but Fabricius happened to have named it twice. It, too, is scarce in the Nilgiris. Wynter-Blyth obtained a single specimen at Kallar from where I have two males (16.vi and 29.vi) both taken on animal dung. Hampson lists it as 'rare, 3000-4000 ft'. The rarity is difficult to understand since the species may be common on the South Indian plains, e.g. around Bangalore, and one of the food plants is the tamarind tree of which Kallar has a fine series of old specimens. The species is found from Sri Lanka practically throughout the Oriental region.

ACRAEINAE

227. **Acraea terpsicore** Linné (*Telchinia violae*)

The TAWNY COSTER is the only South Indian representative of a large subfamily and genus that is strongly centred on the Afrotropical region, but *A. terpsicore* is endemic to Sri Lanka and the Indian subcontinent. It is most closely related to the African and Arabian *A. neobule*, and according to le Doux (1922) the name *terpsicore* is the valid one (see discussion in Larsen 1983). In the Nilgiris the butterfly is not rare and often common and may be found practically anywhere at all levels except inside the densest forests. The flight is usually slow and not far from the ground. Flowers are visited regularly, but not damp patches.

LIBYTHEINAE

228. **Libythea myrrha carma** Fruhstorfer

The CLUB BEAK is a fairly common butterfly especially in the subtropical zone, but it may also be found in the tropical evergreen forests and occasionally breeds in *sholas* on the plateau. It participates in the migrations, and I must assume that is why I have seen a specimen in the driest possible habitat near Masinagudi. Flowers are rarely if ever visited, but at certain times of the year damp patches hold great attraction. It is sometimes found with the next species, *L. lepita*, which is usually much the more numerous, though more linked to the lower levels. The range covers Sri Lanka, South India, then from Kulu east to southern China and Sundaland.

229. **Libythea lepita lepitoides** Moore

The COMMON BEAK is indeed more common than the preceding species, but generally at somewhat lower levels, especially in the denser mixed deciduous forest formations. Here it is sometimes very abundant just before the start of the rains, while only occasional specimens are met with during the rainy season. It is a frequent visitor to damp patches, but does not seem to visit flowers. It has been suggested that species should be considered a form of the European *L. celtis* Fuessly, but I have not seen convincing evidence for this view. Certainly its habitat choice in southern India is very different from that of the European species which extends to at least Chitral. The species is found in Sri Lanka, where it is very rare, in South India, and from Jammu east along the Himalayas to Thailand, South China and Japan.

[*Note on the* LIBYTHEINAE. Mention must be made of a recent paper by Shields (1985) revising the genus. In this he accepts two subspecies of *L. myrrha* in South India, in-

cluding the Sri Lankan ssp. *rama* as well as *carma* and draws a dividing line between the two that is not supported by his locality list. Both subspecies are quoted from the Nilgiris which does not make much biogeographical sense. It would have been more logical to merge the South Indian and the Sri Lankan subspecies which are not well differentiated. He considers *L. lepita* to be conspecific with the European *L. celtis* in the combination *L. celtis lepita* Moore and accepts the presence of the latter in South India. The taxon *lepitoides* is also accepted as South Indian, but now in the combination *L. laius lepitoides.* This butterfly is an East African one. All this is done without reference to the genitalia (a few genitalia have been copied from other books (such as Eliot 1978) without giving a source) though the genitalia clearly provide better phylogenetic characters than the wing patterns. I would be very surprised if there really are more than two species in South India.]

HESPERIIDAE

Coeliadinae

230. **Bibasis jaina fergusonii** de Nicéville (*Ismene jaina*)

The orange striped awlet is very rare in the Nilgiris and in most of its range. It will always be found in the wetter lowland evergreen forests. There is but a single record from the area, a specimen seen in a local collection by Wynter-Blyth, without data but apparently without doubt from the Nilgiris. Its general habits are probably like the rest of the Coeliadinae, including a tendency to fly chiefly at dawn and dusk. The range covers the Western Ghats, then from Mussoorie to Thailand, Indo-China, Taiwan and Sulawesi, with very similar species replacing it in Malaysia and the rest of Sundaland. It is interesting that this species is absent from Sri Lanka while *B. oedipodea ataphus* Watson is present, though not represented in South India.

231. **Bibasis sena sena** Moore

The orange-tail awl seems generally to be a rare butterfly in the Nilgiris. It was so considered by Hampson and Wynter-Blyth failed to procure it. Gordon Thompson collected a small series of worn specimens on the Nadgani Ghat on one of our visits, and I saw one about a week later, but these are the only observations we have of imagines. It was therefore somewhat surprising that we found quite a few larvae at Kallar in August and September, beautiful creatures that are well described in Woodhouse (1952). What purpose the bold larval markings found in many Coeliadinae serve is difficult to say considering that they spend the entire day in a hide made from rolled up leaves and only come out to feed at night. They hatched readily in captivity, though a week later in Kotagiri than in the much warmer Metupalayam. When drying their wings they hold the wings in a horizontal position and fold the antennae back along the thorax in a position wholly at odds with any natural resting posture, but this appears to be general for the Hesperiidae. The adults are very tough, nearly as much so as *Thaduka multicaudata,* and are almost impossible to despatch with the customary pinch of the thorax. This is not the case in *Hasora* or *Badamia.* The adult is somewhat reminiscent of the common *Hasora chromus* but the orange hindwing cilia will tell them apart. The distribution covers Sri Lanka and South India, then from Simla east to the Philippines and Sundaland. It seems to be rare in most of its range.

232. **Hasora chromus chromus** Cramer (*Hasora alexis*)

The common banded awl shares with *Badamia exclamationis* the distinction of being

the only South Indian Coeliadinae to be tolerably common and to be found outside of the wet lowland forest habitats. This is linked to the fact that both of these species are migratory. I have specimens from all types of habitat between the foot of the mountain and 2000 m at Kodanad. Though normally not at all common, it may occur in huge quantities. At Kallar in the beginning of October 1986 masses of larvae were found on *Pongamia* trees, many of which were defoliated so that pupation took place more or less in the open. The normal larval ground colour is a light yellowish green, but larvae on very crowded trees tended to be almost black. Such records of complete defoliation are also found in older literature. The adult butterflies visit both flowers and damp patches but are generally very wary. The distribution covers the whole of the Oriental region as well as the Papuan subregion, Australia and the Bismarck Islands.

233. **Hasora taminatus taminatus** Hübner

The WHITE BANDED AWL is more tied to forest habitats than is the preceding species and it appears not to be very common in the Nilgiris. Though Hampson records it without detail, Wynter-Blyth failed to find it, and I have taken it on three occasions only in the forests surrounding Glenburn. I have taken it on both flowers and at water. It would appear to be restricted to evergreen forests at low and middle heights. It is found in Sri Lanka and South India, then from Sikkim to Sundaland and the Moluccas.

234. **Hasora badra badra** Moore

The COMMON AWL never seems very common anywhere and certainly not in the Nilgiris. The first record in print is one by Wynter-Blyth in a supplement to his main Nilgiri paper. I have three females on three different dates on the Nadgani Ghat, all coming to Lantana flowers on dull, drizzly days. Even by the standards of the genus its flight is rapid and I suspect it is largely crepuscular. It is found in Sri Lanka and South India, then again from Nepal east to Sundaland and Sulawesi.

235. **Badamia exclamationis** Fabricius

The elongated forewings of the BROWN AWL render this large skipper quite unmistakable. Occasional dry season specimens are very small, lacking entirely in hyaline spots, being so dissimilar from the usual that I initially thought it was a distinct species. Generally the species is not rare in evergreen forests at the lower and middle levels and it may sometimes become very common indeed. At such times it will also tend to be met with in more open country and on the plateau. Occasionally it may migrate in considerable numbers and it participated in the main migrations at 2000 m during October 1986. The flight is extremely rapid, but rarely sustained, and when the butterflies settle under leaves as they usually do, then they are easily caught as they trust their concealment. When visiting flowers, as they do freely, they are very wary, as they are during their occasional visits to damp patches. In 1986, co-incidental with the migrations, we found large quantities of the very attractive larvae at Kallar and they bred easily in captivity. The range covers the entire Oriental region, with extensions to New Guinea and Australia, and into the Pacific at least to Samoa.

236. **Choaspes benjaminii benjaminii** Guérin-Méneville

The INDIAN AWLKING is without discussion the finest of the skippers known from the Nilgiris, though *Bibasis gomata* Moore would give it a good run for the money if it were to turn up. The indigo-blue and shining green of both sexes are quite different from any of the

other skippers. This is mainly a montane butterfly that has been recorded as low as Runnymede. by Wynter-Blyth. It is usually considered to be not rare, but I did not come across it in 1986. However, during the 1950ies we would occasionally find large numbers on Lantana near Kotagiri on dull days. The species is found in Sri Lanka and South India, then from Kangra east to southern China, Japan and Palawan.

PYRGINAE

237. **Celaenorrhinus leucocera** Kollar

The COMMON SPOTTED FLAT is one of three fairly similar species of almost identical habits, though *C. ruficornis* appears to be ecologically more or less separated from the two others. The present species and *C. ambareesa* are often found flying in the same spot. Both are butterflies of rather shady forest, along roads and in other places where they have sufficient space for the furious early morning patrolling. These patrols are male territorial and mate locating flights covering a length of up to ten metres and they are conducted with such speed that the human eye can barely follow it. At frequent intervals the butterfly will alight on the underside of a leaf for rest, but it rarely basks on the top of leaves or at vantage points in the manner of *Caprona* and *Tagiades.* Flowers are sometimes visited, damp patches only very occasionally. It is mainly found in the lowland evergreen and mixed deciduous forests, but also penetrates the subtropical evergreen. The range includes South India, the Himalaya from Jammu east to Indo-China and southern China, but not south to Sundaland proper.

238. **Celaenorrhinus ambareesa** Moore

The MALABAR SPOTTED FLAT is not rare on road verges and clearings in evergreen and mixed deciduous forest, but it is not found on the plateau. Its habits are so much like those of the preceding species that they cannot be differentiated in nature. It is an Indian endemic being found in suitably wooded areas of peninsular India south of the Indo-Gangetic plain. It is interesting that all three South Indian members of the genus should be lacking from Sri Lanka, which in turn has its own distinctive endemic species in the form of *C. spilothyrus* Felder & Felder.

239. **Celaenorrhinus ruficornis fusca** Hampson

The TAMIL SPOTTED FLAT is rather rare in the Nilgiris proper. Wynter-Blyth took but a few at Nadgani and I only have it from the Nilgiri Wynaad. I did, however, find it quite common in moist-deciduous forest in the Biligiriranga Mountains. Hampson thought it common and since he was living in the Wynaad on the fringes of moist-deciduous forest I suspect the species is specially adapted to this type of habitat. In habits it does not differ from the other members of the genus. The nominate subspecies is from Java; another subspecies occurs in Sulawesi, so the South Indian population is strongly disjunct.

240. **Tagiades japetus obscurus** Mabille
(*Tagiades atticus & distans*)

The COMMON SNOW FLAT is almost identical with the next species which, however, always lacks the two hyaline discal spots of the upper forewing in spaces 2 and 3. These are always present in *T. japetus* though they may be minute. The species is not rare in evergreen forest formations except on the plateau and may be found in mixed deciduous forest. The flight is very rapid, looking like a series of white flashes, but the butterfly is territorial and often returns to a given perch. It is a frequent visitor to flowers but only occasional at damp patches, despite the fact the chosen habitat is often along rivers and streams. The

range covers practically the entire Oriental region and the genus is also represented in Africa.

241. **Tagiades gana silvia** Evans
(*Tagiades obscuros*)

The IMMACULATE SNOW FLAT in South India is very much like the preceding species under which the distinguishing characters are mentioned. I did not distinguish between the two while in the field, but my recollections and specimens in my collection indicate that the two are so close in habits, habitat and local distribution that nothing special can be said about this butterfly except that it seems slightly the rarer of the two. The name *obcuros* has been applied to South Indian populations in older literature. The range, again, covers most of the Oriental region, but neither of two species are found in Sri Lanka.

(*to be continued*)

A CONTRIBUTION TO THE FLORA OF KHATLING GLACIER IN THE GARHWAL HIMALAYA (DISTRICT - TEHRI), U.P.[1]

K. S. Negi, J. K. Tiwari and R. D. Gaur[2]

(*With a text-figure*)

Inspite of several attempts by plant explorers in Garhwal Himalaya, many of the alpine zones have practically remained untouched. Khatling Glacier, a botanically little known alpine zone is the source of the Bhillangana river, a tributary to the Ganges in Tehri District, U.P. The article briefly describes the angiosperms collected from Khatling during the years 1984-85. The area under study lies between 30° 31′ 75″–30° 47′ 16″ N and 78° 47′50″–78° 57′ 2″ E, covering an elevation range of 1500 m a.s.l. to 3800 m a.s.l. The dominant families of this zone are Ranunculaceae, Fabaceae, Scrophulariaceae, Rosaceae, Saxifragaceae, Lamiaceae, Apiaceae, Asteraceae, Primulaceae, Polygonaceae, Orchidaceae, Poaceae. A total number of 464 species and 286 genera represented by 87 families have been recorded.

Introduction

The Himalaya has received great attention on various aspects of plant study. However, several interesting zones, still provide significant areas for investigations. Khatling has a great variety of landscapes, climate, flora and fauna with scores of snowy peaks, many of which exceed 6000 m elevation and have their own garlands of glaciers descending in different directions. The river Bhillangana, the main tributary of the Ganges originates from this glacial zone. Mythologically the famed peak Khatling, associated with the name of Lord Shiva, is considered sacred.

This zone of the Himalaya has received comparatively less attention from early botanists due to lack of transport facilities and the presence of natural barriers, rivers and several streamlets during the monsoon. The only noteworthy contributions in the present century were those by Duthie (1906), Osmaston (1927), Smythe (1932, 1938) and Ghildyal (1956). During the last three decades several collectors have trekked through different pockets of Garhwal Himalaya (Rau 1961, 1963, 1975; Gupta 1955, 1957, 1962; Naithani 1967, 1982; Dey *et al.* 1968; Bhattacharyya and Malhotra 1982; Bhattacharyya and Goel 1982; Gaur and Semwal 1983; Semwal 1981, 1984; Kala and Gaur 1982; Hajra and Jain 1983; Negi *et al.* 1985). However, no special emphasis has been given to the flora of this interesting zone of the Khatling Glacier.

In order to fill up the lacuna, explorations in many remote and virgin areas, which were unapproachable in the past, were conducted. Khatling zone as a whole has been undertaken for the study by the Garhwal University in 1984-85 under the "All India Co-ordinated Research Project on Ethnobiology". Keeping this in view, the information about the local names has been gathered besides the floristic study of the area.

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Geography and Climate

The Khatling Glacier in Tehri District is surrounded by snow peaks of the Jogin Group (6466 m); Sphetic Brishtvon (6905 m); Kirtistambha (6402 m); Bartekanta and Meru (6579 m). It is situated at a height of 3658 m a.s.l. and lies in between 30°31′75″ to 30°47′16″ N and 78°47′50″ to 78°57′2″ E. It is also known for the grandeur of natural beauty, including wild flora and fauna, meadows, rivers and panoramic scenes. The explored area includes sub-tropical zones to alpine zone ranging from 1500 m to 3800 m a.s.l. The approach to the Khatling begins at Ghutoo, a place connected to Rishikesh, Dehradun and Srinagar. Ghutoo is the last bus terminus from where one has to treck 45 Km. to the Khatling Glacier. The route leads through Reeh and Gangi. Gangi, enroute to Khatling Glacier, is the last inhabited village. The 25 Km spectacular hill route runs through dense forest and meadows like Deokhuri, Kalyani, Sonari, Birodh, Paayara, Jalkala, Banglani, Henuri, Tonyaroo, Soonaroo, Kharsoli, Pachari, Raipharkot, Naumuthia, Bhelbagi, Bhumka, Tamakund, and Bajloo to reach the Khatling Glacier. (Fig. 1). The area fascinates visitors and travellers all round the year from all over India and elsewhere.

The hilly topography with gradual slopes has sub-tropical, temperate, alpine scrubs and alpine meadows which serve as good grazing pastures for sheep and goats.

Gangi (2500 m), has temperate and alpine zones, and the climatic conditions include fog, heavy hailstorms, extremely low temperature, high light intensity, high wind velocity and lower oxygen and carbon dioxide concentration. The upper reaches of Kharsoli and upper mountainous limits of the area are covered with snow for nearly 7-8 months in a year.

Vegetation and Floristic Composition

The vegetation of Khatling is characterised by a comparatively lush flora represented by sub-tropical, temperate and alpine species in response to altitude. The sub-tropical terraced fields at Dhoperdhar and Ghutoo are spotted with shrubs of *Rosa brunonii, Debregeasia salicifolia, Prinsepia utilis, Berberis chitria, Desmodium laxiflorum, D. sambuense, Zanthoxylum armatum* mixed with *Alnus nepalensis, Lyonia ovalifolia, Rhus parviflora, Ficus cunia, F. scandens* and common sub-tropical herbs like *Dicrocephala integrifolia, Urtica parviflora, Cirsium wallichii* and several others.

Ghutoo is a well known centre as a market, where villagers bring many articles of food (wild as well as cultivated), medicinal plants, wool etc. and interchange them for articles for their daily need.

Reeh is located at 10 km distance from Ghutoo. Leaving the village, the track joins a mule track through the Pine forest and leads to Gangi. From Reeh to Gangi the distance is about 10 km and *Pinus roxburghii, Quercus leucotrichophora, Eurya acuminata, Ilex dipyrena, Symplocos ramosissima, Juglans regia, Myrica esculenta, Coriaria nepalensis, Cotoneaster affinis,* var. *bacillaris, Cinnamomum tamala, Neolitsea umbrosa, Euonymus tingens,* and *Viburnum cotinifolium* form the mixed forests. Some of the well represented undergrowth of these forests are *Flemingia vestita, Myriactis nepalensis, M. wallichii, Delphinium roylei, Boenninghausenia albiflora, Galinsoga parviflora, Veronica agrestis, Circaea imaicola, Murdania divergens, Mondo intermedium, Tragopogon gracilis, Spiranthes sinensis, Goodyera repens, Malaxis cylindrostachya, Gentiana capitata, Sopubia trifida* with climbers such as *Holboellia latifolia, Schisandra grandiflora, Clematis connata, C. montana, Galium rotundifolium, Rubia cordifolia* and *Smilax glaucophylla.*

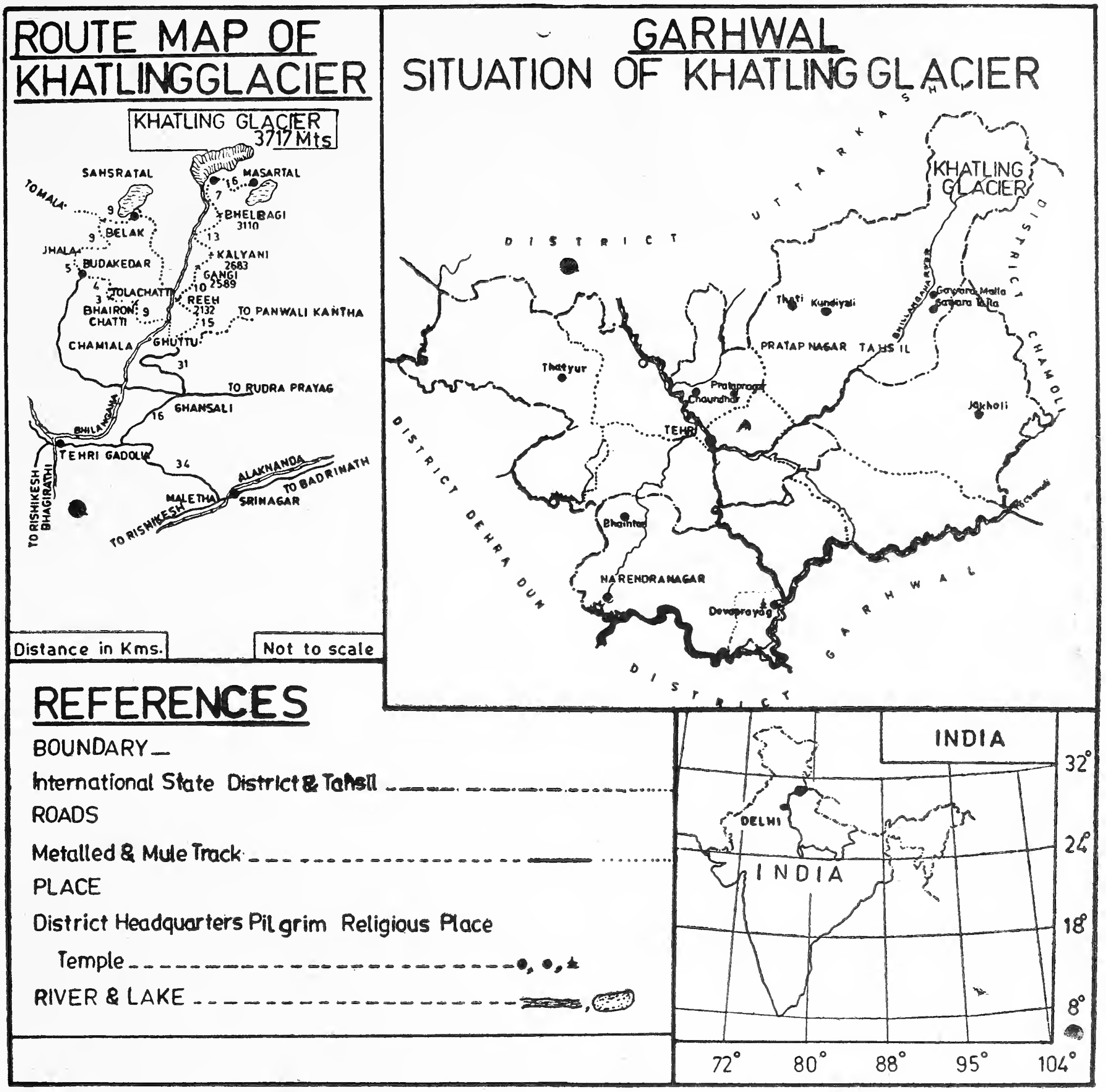

Fig. 1. Map of Khatling Glacier.

Gangi, the last inhabited village on way to Khatling, is well known for its Gangwal tribes, of approximately 120 families living in their own culture. The inhabitants of Gangi are simple and by nature extremely hospitable to visitors. They have deep sense of aesthetic beauty which finds expression in their works of household art.

There are a number of meadows after Gangi which hold a lush flora and present a beautiful sight.

The typical alpine grasslands or meadows

are composed mainly of the clumps of *Danthonia cachymeriana, Dactylis glomerata, Deyeuxia pulchella, D. scabrescens, Kobresia nitens,* and *Phelum alpinum.* Some characteristic alpine herbs found within these clumps are *Corydalis cashemeriana, C. cornuta, C. govaniana, C. meifolia, Saxifraga brunoniana, S. diversifolia, S. filicaule, Aconitum heterophyllum, Orchis latifolia, Delphinium vestitum, Heracleum candicans* and *Selinum vaginatum.*

An interesting plant *Carex rostrata* Stocks has been collected for the first time from the area.

There are temporary settlements of tribal population from April-Oct., of 4 or 5 families in different meadows, i.e. Deokhuri, Sonari, Kalyani and upto Birodh with their sheep, goats, buffaloes and cows. In addition to the cattle rearing, they cultivate *Fagopyrum esculentum,* and *Solanum tuberosum.*

The higher elevation of Bhelbagi represents temperate vegetation consisting of trees and shrubs such as *Quercus semecarpifolia, Abies pindrow, Acer caesium, Caraegna brevsipina, Betula utilis, Lonicera myrtillus, L. quinquelocularis, Piptanthus nepalensis, Ribes alpestre, R. glaciale, Sorbus cuspidata, Syringa emodi, Sorbus foliolosa, S. aucuparia, Taxus wallichiana,* and ground vegetation of species of *Aconitum, Aster, Fragaria, Gentiana, Morina, Jurinea, Rumex, Rheum, Pleurospermum, Potentilla, Selinum,* and other.

Khatling can be clearly seen from a point, Bhelbagi, 4 km after the meadow. The Khatling massif is a tall straight rock having a broad base and a narrow peak thus having a pyramidal outline, which is always snow covered. There are many peaks surrounding the Khatling, such as, Rachotra, Chatangrya, Patangrya,, Konagaroo while on the other side Rutangaira, Lamdokhari, Khaameem, Muglanya, Kunalaya can be seen encircling either side of Khatling. Across the glacier a route leads to Mahisartal or Masurtal. The journey is rather difficult as the route is through the glacier interspread with large crevices and there is always the risk of losing foothold or of being hit by falling boulders.

A big stone everhangs in the shape of a cave at Bhumka, where usually trekkers take rest even at night. Blackish granite boulders flanked by snow begin at Bhelbagi and provide a typical habitat for *Meconopsis aculeata, Saussurea obvallata, S. graminifolia, S. simpsoniana, S. taraxacifolia, Leontopodium alpinum, Sedum quadrifidum, S. linerifolium, Achillea millefolium* and several other species.

The last energetic and adventurous trekking is almost over the permanent snow line and the glacier is visible, amidst the vast panorama of the distant mountains of Chauki, Dandakharak and Khatling proper.

A few and interesting species of the rocky slopes are the peculiar woolly *Saussurea obvallata, S. simpsoniana, Salix daphnoides, S. furcata,* and other herbs like *Rheum emodi, Allium stracheyi, Rumex acetosa* and *Megacarpaea polyandra.*

In rocky areas grow herbs like *Sagina saginoides, Sedum linearifolium, S. quadrifidum, Saxifraga filicaulis, Swertia cordata, Rhodiola crenulata, Primula elliptica, P. floribunda, Androsace sarmentosa, Pleurospermum angelicoides, Thermopsis barbata, Lysimachia alternifolia, L. pyramidalis, Filipendula vestita, Arabidopsis himalayana, Nardostachys grandiflora, Erigeron alpinus, Valeriana hardwickii, Gentiana carinata.*

Gentianella tenella, G. stipitata, and alpine grasses are quite common. The route passes through a wide boulder spread basin which occupies a considerable area and terminates in the Khatling Glaciers, a vast glacier and from an ice cave in its snout emerges the Bhillingana and flows down towards Tehri, where it meets with Bhagirathi.

Enumeration of Species

Collections were made during the year 1984-85. The specimens were compared with authentic specimens at the Herbarium of Botanical Survey of India, Northern Circle, Dehradun (BSD). The local names of the plants, where available, have been given after the botanical names and localities with altitude have also been mentioned. Field number of each specimen is given in bracket and the specimens are preserved in the Herbarium of the Garhwal University, Srinagar, U.P. (GUH). Bentham and Hooker's system is followed with slight modification as proposed by Hutchinson (1973) in the arrangement of families.

DICOTYLEDONS

Ranunculaceae

Aconitum atrox (Bruhl) Mukerjee (Loc.-Meetha Bish)

Syn. *A. balfourii* Stapf

Large erect herb with blue flowers. Kharsoli, 2800 m. Sept. 1985 (5053).

A. heterophyllum Wall. ex Royle (Loc.-Atis)

Small herb, stem leaves sessile, not lobed while lower leaves 3-5 lobed. Flowers dull blue purple veined. Paachari, 2800 m. May 1984 (1053).

A. violaceum Jacq. ex Stapf (Loc.-Dudhiya atees, Patees)

Syn. *A. napellus* var. *multifidum* (Royle) Hk.

Erect small herb with blue flowers. Bhumka, 3200 m. Nov. 1985 (4536).

Actaea spicata Linn. var. **acuminata** (Wall. ex Royle) Hara

Erect herb with white flowers and globose fruits. Kharsoli, 2800 m. July 1984 (5608).

Anemone obtusiloba D. Don

Tufted herb with variable colour of flowers, white, lemon yellow, deep blue or sometimes white with purple veins. Bhelbagi, 3100 m. May 1984 (4813).

Aquilegia pubiflora Wall. ex Royle

Large pubescent herb. Flowers drooping, dark purple. Kalayani, 2600 m. June 1984 (1231).

Caltha palustris Linn.

Glabrous herb with bright yellow flowers. Bhelbagi, 3100 m. May 1984 (979).

Clematis connata DC.

Glabrous climber with cream white bell shaped flowers. Gangi, 2500 m. July 1984 (1232, 3115).

C. montana Buch.-Ham. ex DC.

Large climber on *Prunus* spp. in Oak-Rhododendron forest. Flowers white. Gangi, 2500 m. April 1984 (1229).

C. puberula Hook. f. et Thoms.

Syn. *C. nutans* Royle

Downy climber with pale yellow flowers. Reeh, 2100 m. April 1984 (628).

Delphinium roylei Munz.

Large hoary herb with blue flowers. Gangi, 2500 m. May 1984 (1235).

D. vestitum Wall. ex Royle (Loc.-Nirbishi)

Large hairy herb with dull blue flowers. Bhelbagi, 3100 m. Aug. 1985 (1230).

Oxygraphis polypetala (Royle) Hook. f. et Thoms.

Small tufted herb with bright yellow flowers. Bhumka, 3200 m. June 1984 (1236).

Ranunculus hirtellus Royle ex D. Don

Hairy herb with yellow flowers. Bhelbagi, 3100 m. May 1984 (724).

R. diffusus DC.

Decumbent hairy herb with bright yellow flowers. Reeh, 2100 m. June 1984 (808).

R. laetus Wall.

Herb with yellow flowers. Reeh, 2100 m. June 1984 (725).

Thalictrum alpinum Linn.

Small herb with yellowish green flowers. Bajloo, 3500 m. June 1984 (1228).

T. cultratum Wall. subspp. **platycarpum** (Hook. f. et Thoms.) Bruhl.

Syn. *T. platycarpum* Hook. f. et Thoms.

Glabrous herb with greenish-white flowers. Bhelbagi, 3100 m. June 1984 (1253).

T. javanicum Blume (Loc.-Pilijari)

Large herb with white flowers. Reeh, 2400 m. June 1984 (817).

PAEONIACEAE

Paeonia emodi Wall. ex Royle (Loc.-Tonkanya)

Large erect herb with white flowers in the axils of upper leaves. Ghutoo, 1500 m. April 1984 (457).

SCHISANDRACEAE

Schisandra grandiflora (Wall.) Hook. f. (Loc.-Jogna)

Climber in Oak-Rhododendron forest with white fragrant flowers. Gangi, 2500 m. May 1984 (4506).

LARIDZABALACEAE

Holboellia latifolia Wall var. **angustifolia** Hook. f. (Loc.-Gomphala)

Large climber. Flowers dark-purple-brown and fragrant flowers. Leaflets 7-9, narrow. Gangi, 2500 m. June 1984 (4524).

H. latifolia Wall. var. **latifolia** Wall. (Loc.-Gomphal)

Large climber with dark purple brown and fragrant flowers. Leaflets 3-5, narrow. Gangi, 2500 m. June 1984 (4524).

BERBERIDACEAE

Berberis aristata DC. (Loc.-Kingor)

Large shrub, yellow flowers with blue berries. Pachari, 2800 m. June 1984 (4630).

B. jeschkeana Schneid. (Loc.-Kingore, Choter)

Dwarf shrub, yellow flowers with red berries. Paachari, 2800 m. June 1984 (1237).

B. lycium Royle (Loc.-Choter)

Large shrub. Yellow flowers with blue berries. Birodh, 2700 m. June 1984 (4630).

PODOPHYLLACEAE

Podophyllum hexandrum Wall. ex Royle (Loc.-Ban Kakri)

Syn. *P. emodi* Wall. ex Hook. f. et Thoms.

Large erect rhizomatous herb. Flowers pinkish white and orange yellow fruit. Bhumka, 3200 m. June 1984 (4525).

PAPAVERACEAE

Meconopsis aculeata Royle

Prickly herb with blue purple flowers. Tamakundo, 3400 m. June 1984 (4819).

FUMARIACEAE

Corydalis cashemeriana Duthie ex Prain (Loc.-Mamiri)

Small herb. Flowers sky blue with dark blue tips. Naumuthia, 2900 m. July 1984 (1240).

C. cornuta Royle

Small herb with bright yellow flowers. Bhumka, 3200 m. July 1984 (1239).

C. govaniana Wall. (Loc.-Mamiri)

Erect herb with bright yellow flowers. Bhumka, 3200 m. July 1984 (1239).

C. meifolia Wall.

Herb. Flowers yellow with purple tips. Khatling, 3600 m. Aug. 1985 (1238).

BRASSICACEAE

Arabidopsis himalaica (Edgew.) O. E. Schulz.

Syn. *Sisymbrium himalaicum* Edgew.

Herb with white purple flowers. Bhumka, 3200 m. May 1984 (5731).

Erysimum hieraciifolium Linn.

Erect herb with orange-yellow flowers. Deokhuri, 2700 m. Oct. 1985 (1241).

Megacarpaea polyandra Benth.
(Loc.-Barmoola)

Large herb with light yellow flowers. Bhelbagi, 3100 m. June 1984 (5103).

POLYGALACEAE

Polygala crotalarioides Buch.-Ham. ex DC.

Hairy decumbent with pink flowers. Sonari, 2600 m. Aug. 1984 (701).

VIOLACEAE

Viola betonicifolia subspp. **nepalensis** Backer
(Loc.-Dundibirali)

Syn. *V. patrini* var *nepalensis* DC.

Small herb with yellow flowers, lower petal streaked black. Kharsoli, 2800 m. June 1984 (4567).

V. biflora Linn.

Decumbent herb with yellow flowers. Paachari, 2800 m. June 1984 (2708).

V. canescens Wall. ex Roxb. (Loc.-Banfasha)

Stemless pubescent herb with white flowers. Jalkala, 2700 m. May 1984 (820).

CARYOPHYLLACEAE

Gypsophylla cerastioides D. Don

Hairy herb with white flowers. Bajloo, 3500 m. May 1984 (4628).

Sagina saginoides (Linn.) Karsten

Syn. *S. procumbens* Edgew.

Small glabrous herb with white flowers on rocks. Gangi, 2500 m. May 1984 (1014).

Silene inflata Smith (Loc.-Tumri)

Glabrous herb with white flowers. Naumuthia, 2900 m. July 1984 (4628).

Silene laxantha Majumdar

Syn. *S. pilosa* Edgew.

Hairy herb with purple flowers on rocks. Saura, 2800 m. Aug. 1984 (989).

S. thomsonii Majumdar (Loc.-Tumri)

Syn. *S. indica* Roxb. et Otth.

Lychnis nutans Benth.

Glandular herb with green, purple veined flowers. Saura, Banglani, 2900 m. June 1984 (866).

Stellaria monosperma var. **paniculata** (Edgew.) Majumdar

Syn. *S. paniculata* Edgew.

Pubescent herb with white flowers. Naumuthia, 2900 m. Aug. 1985 (741).

S. patens D. Don

Syn. *S. longissima* Wall.

Glabrous as well as hairy herb with white flowers. Banglani, 2700 m. June 1984 (868).

HYPERICACEAE

Hypericum elodeoides Choisy

Herb with yellow flowers. Deokhuri, 2700 m. Aug. 1984 (787, 1744).

H. oblongifolium Choisy (Loc.-Phenuli, Basanti)

Syn. *H. cernuum* Roxb.

Shrub with yellow fragrant flowers. Reeh, 2100 m. April 1984 (674).

Norisca urala (Hamilt. f.) Koch.

Syn. *Hypericum patulum* Thunb.

Evergreen shrub with yellow flowers in Oak-Rhododendron forest. Reeh, 2100 m. Aug 1985 (975).

TERNSTROEMIACEAE

Eurya acuminata DC.

Small tree with fragrant flowers and green slender fruit in Oak-Rhododendron forest. Gangi, 2500 m. Sept. 1985 (1242).

MALVACEAE

Hibiscus pungens Roxb.

Erect herb. Flowers yellow with purple

centre. Ghutoo, 1500 m. Aug. 1984 (672).

Malva verticillata Linn.

Large erect herb with purplish flowers. Gangi, 2500 m. Aug. 1984 (4568).

TILIACEAE

Triumfetta pilosa Roth.

Large herb with yellow flowers. Fruits densely pubescent with hooked spines. Reeh, 2400 m. June 1984 (1220).

LINACEAE

Linum mysorense Heyne

Glabrous herb with yellow flowers. Reeh, 2100 m. Aug. 1984 (789).

GERANIACEAE

Geranium ocellatum Camb.

Hairy herb with pinkish white flowers. Deokhuri, 2700 m. June 1984 (1043).

BALSAMINACEAE ..

Impatiens brachycentra Kar. & Kir.

Glabrous herb with white flowers. Raipharkot, 2800 m. Aug. 1984 (1243).

I. roylei Walp.

Herb with pale purple flowers. Pachari, 2800 m. Aug. 1984 (855).

I. scabrida DC. (Loc.-Chaul)

Pubescent herb. Flowers yellow spotted with red. Reeh, 2100 m. Aug. 1985 (1103).

RUTACEAE

Boenninghausenia albiflora Reich. (Loc.-Pishukhaur)

Herb with white flowers. Gangi, 2800 m. Aug. 1985 (1734, 1774).

Skimmia laureola Sieb. et Zucc. ex Walp. (Loc.-Nairpati, Kedarpati)

Unarmed shrub. Leaves when crushed emit orange fruit's smell. Flowers greenish-white. Banglaani, 2700 m. May 1984 (856).

Zanthoxylum alatum Roxb. (Loc.-Timru)

Shrub or small tree with red or gland dotted fruits. Reeh, 2100 m. July 1984 (1502).

AQUIFOLIACEAE

Ilex dipyrena Wall.

Tree with scarlet fruits. Gangi, 2500 m. June 1984 (5612).

CELASTRACEAE

Euonymus echinatus Wall.

Evergreen shrub with greenish-yellow flowers and echinate fruits. Sônari, 2600 m. July 1984 (5611).

E. hamiltonianus Wall.

Small deciduous tree with creamy white flowers and four lobed fruits. Sonari 2600 m. Oct. 1985 (5610).

E. tingens Wall. (Loc.-Konk, Bhanlai)

Evergreen tree with yellowish tinged flowers marked with brown. Banglani, 2700 m. Oct. 1985 (4738).

RHAMNACEAE

Rhamnus triquetra Wall. ex Roxb. (Loc.-Halith, Phalith)

Unarmed small tree with greenish flowers. Reeh, 2100 m. July 1984 (1244).

R. virgatus Roxb.

Thorny deciduous shrub with greenish, yellow flowers and green ovoid fruits. Gangi, 2500 m. June 1984 (4157).

VITACEAE

Parthenocissus semicordata var. **semicordata** (Wall. ex Roxb.) Planch.

Big climber in Oak-Rhododendron forest

with green fruits. Sonari, 2600 m. July 1984 (1245).

Tetrastigma serrulatum (Roxb.) Planch.
Climber with red spherical fruits. Reeh, 2100 m. July 1984 (4586).

ACERACEAE (SAPINDACEAE)

Acer caesium Wall. ex Brand. (Loc.-Manik)
Deciduous tree with greenish flowers. Kalyani, 2600 m. July 1984 (703, 4703).

HIPPOCASTANACEAE

Aesculus indica Colebr. (Loc.-Paamal, Panger)
Large deciduous tree with white or purplish tinged flowers. Tonyaroo, 2750 m. June 1984 (4888).

ANACARDIACEAE

Cotinus coggyria Scop.
Syn. *Rhus cotinus* Linn.
Deciduous shrub with pale-purple flowers. Reeh, 2100 m. April 1984 (1246).

Rhus javanica Linn. (Loc.-Titmulya, Deshmela)
Syn. *R. chinensis* Miller
R. semicordata Murr.
Tree, with yellow flowers with red fruits. Gangi, 2500 m. July 1984 (4562).

CORIARIACEAE

Coriaria nepalensis Wall. (Loc.-Masuri, Gangaroo)
Shrub with succulent black wrinkled fruits. Gangi, 2500 m. April 1984 (4507).

FABACEAE

Aeschynomene indica Linn.
Glabrous herb, streaked with purple yellow flowers. Reeh, 1600 m. Aug. 1984 (760).

Astragalus cashmiriensis Bunge (Loc.-Rudravanti)
Herb with pink flowers. Bajloo, 3500 m. July 1984 (4817).

Caragana brevispina Royle (Loc.-Gughtai)
Erect shrub with yellow flowers. Panyara, Birodh, 2750 m. May 1984 (1248).

Desmodium elegans DC.
Syn. *D. tiliaefolium* G. Don
Large shrub with pale-lilac flowers. Reeh, 2100 m. July 1984 (1251).

D. laxiflorum DC.
Erect shrub with hairy pink flowers. Ghutoo, 1500 m. July 1984 (656).

D. motorium (Houtt.) Merill.
Shrub with purple flowers. Reeh, 2000 m. Aug. 1984 (776).

D. podocarpum DC.
Herb with pink flowers and two jointed pods. Reeh, 2100 m. Sept. 1985 (652).

D. sambuense DC.
Syn. *D. flouribundum* Benth.
Shrub with pink or purple flowers. Ghutoo, 1500 m. Aug. 1984 (654).

Eriosema chinense Vogel (Loc.-Bhatya)
Bulbous herb with yellow flowers. Reeh, 2100 m. Aug. 1984 (4610).

Indigofera heterantha Wall. ex Brandis (Loc.-Sakinya)
Syn. *I. gerardiana* Wall.
Silvery pubescent tomentose shrub with red or purple flowers. Gangi, 2500 m. June 1984 (976, 821).

Lespedeza gerardiana Grah. ex Baker
Shrub with pale yellow flowers. Reeh, 2100 m. Aug. 1984 (790).

Lotus corniculatus Linn.
Glabrous herb. Flowers yellow streaked crimson. Henuri, 2750 m. July 1984 (3063).

Parochetus communis Buch.-Ham. ex D. Don
Prostrate hairy herb with deep violet flowers Tonyaroo, 2750 m. June 1984 (5727).

Piptanthus nepalensis (Hook.) D. Don (Loc.-Fundanu, Phundanu)

Deciduous shrub with yellow flowers. Raipharkot, 2800 m. May 1984 (1248).

Thermopsis barbata Royle

Herb with violet or deep purple flowers. Bhelbagi, 3100 m. June 1984 (3089).

ROSACEAE

Aruncus dioicus subspp. **triternata** (Maxim.) Hara

Syn. *A. silvestris* Kostel et Maxim.

Erect herb with white flowers. Banglani, 2700 m. July 1984 (1268).

Cotoneaster acuminatus Lindl. (Loc.-Chamruins)

Erect deciduous shrub with pink or white fragrant flowers. Gangi, 2500 m. May 1984 (1255).

C. affinis Lindl. var. **bacillaris** (Lindl.) Schneid. (Loc.-Ruins)

Shrub or small tree with white flowers and black fruits. Gangi, 2500 m. May 1984 (1269).

C. confusus Klotz.

Small tree with white flowers and blue fruits. Jalkala, 2400 m. June 1984 (1266).

C. marginatus (Lindl.) Schld.

Shrub with white flowers are red fruits. Gangi, 2500 m. June 1984 (1257)

C. microphyllus Wall. ex Lindl. (Loc.-Jheri)

Rigid much branched shrub with white flowers and red globose fruits on rocks. Gangi, 2500 m. June 1984 (1254).

C. obtusa Wall. ex Lindl.

Glabrous shrub with white flowers. Banglani, 2700 m. Aug. 1984 (1266).

C. rosea Edgew.

Small tree with white or pink flowers and bright red fruits. Gangi, 2500 m. June 1984 (1265).

C. integrifolia (Roxb.) Klotz.

Shrub with white flowers. Kalayani, 2600 m. June 1984 (1256).

Deutzia staminea R. Br. ex Wall. (Loc.-Ghugti)

Deciduous shrub with white-yellowish flowers. Reeh, 2100 m. June 1984 (1262).

Filipendula vestita (Wall. ex G. Don) Maxim. (Loc.-Ratanjot)

Syn. *Spiraea vestita* Wall. ex G. Don

Erect shrub with yellow-white flowers on rocks. Bhumka, 3200 m. Aug. 1984 (5717).

Fragaria vesca Linn. (Loc.-Gandkaphal)

Herb with white flowers and scarlet fruits. Saura, 2800 m. July 1984 (981, 780).

Geum elatum (Royle) Hook. f.

Herb with yellow flowers. Naumuthia, 2900 m. July 1984 (2720).

Potentilla bifurca Linn.

Small silky hairy herb with yellow flowers. Bhumka, 3200 m. Aug. 1984 (1259).

P. fulgens Wall. ex Hook. (Loc.-Bajaradanti)

Herb with yellow flowers. Jalkala, 2700 m. Sept. 1984 (720).

P. gerardiana Lindley ex Lehm.

Syn. *P. fragarioides* Linn.

Small hairy herb with light yellow flowers. Banglani, 2700 m. July 1984 (1004).

P. leschenaultiana Ser.

Robust hairy herb with yellow flowers. Kharsoli, 2800 m. Aug. 1984 (1258).

P. nepalensis Hook.

Hairy herb with dark crimson flowers. Kalyani, 2600 m. Aug. 1984 (721, 800).

P. polyphylla Wall. ex Lehm.

Glabrous herb with pale flowers. Deokhuri, 2700 m. Aug. 1984 (1261).

Prunus cornuta (Royle) Steud. (Loc.-Jamnai)

Tree with white flowers. Kalayani, 2600 m. May 1984 (4501).

Sorbus cuspidata (Spach.) Hedlund (Loc.-Moli)

Syn. *Pyrus vestita* Wall.

Deciduous small tree with white flowers and greenish-yellow often tinged with red spots fruits. Deokhuri, 2700 m. July 1984 (4507)

Rosa sericea Lindl. (Loc.-Rangel)
Shrub with white flowers. Gangi, 2500 m. May 1984 (4509).

Rubus macilentus Cambes. (Loc.-Peelu Hissol)
Evergreen shrub with white flowers. Henuri, 2750 m. June 1984 (1043).

R. nutans Wall. ex Hook.
Creeping shrub with stiff brown hairs. Flowers white, fruits dark red on rocks. Pachari, 2800 m. Sept. 1984 (4513).

Sibbaldia cuneata Hornem. ex O. Kuntze
Syn. *Potentilla sibbaldi* Hook. f. non Hallier f.
Shrub with pale yellow flowers. Tamakundo, 3400 m. June 1984 (1260).

Sorbaria tomentosa (Lindl.) Rehder.
Deciduous tree with white flowers. Rimchura, 3000 m. June 1984 (4548).

Sorbus aucuparia Linn.
Small tree with pink flowers and red fruits. Gangi, 2500 m. Aug. 1984 (1087).

S. lanata (D. Don) S. Schaur. (Loc.-Moli, Molya)
Syn. *Pyrus lanata* D. Don
Tree with pink flowers and red fruits. Bhelbagi, 3100 m. May 1984 (4511).

S. foliolosa (Wall.) Spach. (Loc.-Kyans).
Syn. *Pyrus foliolosa* Wall.
Small tree with white flowers and red fruits. Rimchura, 3000 m. June 1984 (3706).

Spiraea bella Sims.
Shrub with pink flowers. Paachari, 2800 m. April 1984 (1264).

S. canescens D. Don
Shrub with white flowers. Paachari, 2800 m. May 1984 (5706).

S. gracilis Maxim.
Syn. *S. parvifolia* Bert.
Shrub with white flowers. Naumuthia, 2900 m. June 1984 (5717).

Saxifragaceae

Astilbe rivularis Hamilt.
Erect hairy herb with greenish flowers in moist places. Naumuthia, 2400 m. Aug. 1984 (3083).

Bergenia stracheyi (Hook. f. et Thoms.) Engl. (Loc.- Pashanbhed)
Herb with white flowers on rocks. Tamakundo, 3400 m. Aug. 1985 (5607).

Chrysoplenium tenellum Hook. f. et Thoms.
Procumbent glabrous herb with green, yellow flowers in moist places. Bhelbagi, 3100 m. June 1984 (1252).

Hydrangea heteromella D. Don
Syn. *H. vestita* Wall.
Small tree with yellow-green globose fruits. Deokhuri, 2700 m. May 1984 (3085).

Parnassia laxmanni Pall. ex Schult.
Syn. *P. ovata* Ledeb.
Herb with white flowers. Tonyaroo, 2700 m. April 1984 (4543).

P. nubicola Wall. ex Royle
Small glabrous herb with white flowers on grassy slopes near stream banks. Saura, 2800 m. July 1984 (3161).

Saxifraga brunoniana Wall. ex Sternberg
Herb with yellow flowers. Tonyaroo, 2750 m. June 1984 (846).

S. diversifolia Wall. ex DC. var. **parnassifolia** (D. Don) Engl.
Erect herb with yellow flowers. Henuri, 2750 m. July 1984 (3289).

S. filicaulis Wall. ex Ser.
Procumbent herb with yellow flowers on flat mossy boulders. Bhelbagi, 3100 m. Aug. 1984 (3080).

S. fimbriata Wall.
Herb with yellow flowers. Tamakundo, 3400 m. Aug. 1985 (845).

S. flagellaris Willd. ex Sternb.
Small hairy erect herb with yellow flowers. Chauki, 3500 m. July 1984 (3081).

Grossulariaceae

Ribes alpestre Decne. ex Jacq.
Syn. *R. grossularia* Clarke
Large prickly shrub with greenish flowers

and green fruits. Rimchura, 3000 m. May 1984 (4542).

R. glaciale Wall. (Loc.-Himoch, Kaladani)

Unarmed shrub with green or pink flowers and fruits. Rimchura, 3000 m. May 1984 (4543).

CRASSULACEAE

Rhodiola crenulata (Hook. f. et Thoms.) Ohba

Syn. *Sedum crenulatum* Hook. f. et Thoms.

Herb with purple flowers. Chauki, 3500 m. Aug. 1984 (3066).

Rosularia rosulata (Edgew.) Ohba

Syn. *Sedum rosulatum* Edgew.

Sarmentose fleshy herb with white flowers on moist rocky places in Oak-Rhododendron forest. Kalayani, 2700 m. April 1984 (3064).

Sedum crassipes Wall. ex Hook. f. et Thoms.

Syn. *S. asiaticum* Clarke in FBI non DC.

Succulent herb with yellow flowers on rocks. Bangalani, 2700 m. Aug. 1984 (3065).

S. linearifolium Royle

Succulent herb with red tipped flowers on rocks.

Tamakundo, 3400 m. Sept. 1985 (905).

S. quadrifidum Pall.

Woody herb with short shoots, reddish leaves and flowers. Tamakundo, 3400 m. Sept. 1985 (5313).

Sinocrassula indica (Decne.) Barger

Syn. *Crassula indica* Decne.

Erect succulent herb with yellow flowers. Kharsoli, 2900 m. Sept. 1985 (2067).

ONAGRACEAE

Circaea imaiecola (Asch. et Magn.) Hand.-Manz.

Syn. *C. alpina* Clarke

Erect herb with white flowers on rocks. Gangi, 2500 m. Aug. 1984 (466, 766).

Epilobium roseum (Schret.) Pers. (Loc.-Aatrasu)

Erect herb with pink flowers. Sonari, 2650 m. Aug. 1984 (4560).

Oenothera rosea (Soland) W. Ait.

Erect herb with pink flowers. Reeh, 2100 m. Aug. 1984 (1017).

CUCURBITACEAE

Gomphogyne cissiformis Griff.

Twinner with greenish yellow flowers. Rimchura, 2900 m. Aug. 1984 (1270, 1054).

Melothria heterophylla (Lour.) Cogn. (Loc.-Bon kakri)

Glabrous climber with pale yellow flowers and red fruits. Kalayani, 2650 m. June 1984 (4582).

BEGONIACEAE

Begonia picta Smith (Loc.-Pattharchata)

Succulent herb with pinkish-white flowers on rocks. Deokhuri, 2700 m. Aug. 1984 (4644).

APIACEAE

Bupleurum candolii Wall. ex DC.

Erect herb with yellow flowers. Bhelbagi, 3100 m. July 1984 (4604).

B. falcatum Linn. var. **marginatum** Wall. ex DC.

Erect herb with yellow flowers. Bhumka, 3200 m. Aug. 1984 (4603).

Chaerophyllum acuminatum Lindl.

Erect hairy herb with white flowers. Naumuthia, 2900 m. June 1984 (1276).

C. villosum Wall. ex DC.

Erect large hairy herb with white flowers. Raipharkot, 2850 m. June 1984 (1272).

Heracleum candicans Wall.

Large hairy herb with pinkish white flowers. Bhelbagi, 3100 m. July 1984 (1273).

Ligusticum elatum Clarke

Erect glabrous herb with white flowers.

Kharsoli, 2800 m. Aug. 1984 (1271).

L. marginatum Clarke

Tall herb with white flowers. Naumuthia, 2900 m. Aug. 1984 (1250).

Pimpinella acuminata Clarke

Erect herb with yellow green flowers. Kharsoli, 2800 m. July 1984 (1273).

P. diversifolia DC.

Hairy erect herb with white flowers. Raipharkot, 2850 m. June 1984 (1282).

Pleurospermum angelicoides (DC.) Clarke (Loc.-Lesser)

Syn. *Pterocyclus angelicoides* (Wall.) Klotzsch.

Robust herb with white flowers and oblong-elliptic green fruits. Bajloo, 3500 m. Aug. 1984 (1280).

P. candolii (DC.) Benth.

Aromatic erect herb with purple flowers. Bhelbagi, 3100 m. Aug. 1985 (1277).

P. densiflorum (Lindl.) Clarke

Small tufted herb with greenish white flowers. Bhelbagi, 3100 m. Aug. 1985 (1275).

Selinum vaginatum Clarke (Loc.-Bhutkesh)

Large herb with white flowers. Kharsoli, 2800 m. Sept. 1985 (1281).

Caprifoliaceae

Leycesteria formosa Wall.

Erect glabrous shrub with ovoid red fruits in clusters. Jalkala, 2700 m. Sept. 1985 (1288).

Lonicera angustifolia Wall. ex DC. (Loc.-Gulnar)

Erect shrub with white flowers and red fruits. Bhelbagi, 3100 m. May 1984 (791).

L. myrtillus Hook. f. et Thoms. var. **depressa** Rehder

Syn. *L. parvifolia* Hook. f. et Thoms. non Edgew.

Erect tufted shrub with white flowers and red fruits. Naumuthia, 2900 m. June 1984 (1287).

L. quinquelocularis Hardw.

Large shrub with yellowish-white hairy flowers. On rocks. Birodh, 2700 m. July 1984 (5738).

Sambucaceae

Viburnum cotinifolium D. Don

Large deciduous shrub with dark purple flattened fruits. Gangi, 2500 m. July 1984 (4521).

V. cylindricum Buch.-Ham. ex D. Don (Loc.-Karua)

Syn. *V. coriaceum* Bl.

Small tree with sweet scented flowers and dark purple fruits. Reeh, 2200 m. July 1984 (1228).

V. mullaha Buch.-Ham. ex D. Don (Loc.-Titmulya)

Syn. *V. stellulatum* Wall.

Large shrub with globose bright red fruits. Sonari, 3700 m. Sept. 1985 (4518).

V. nervosum D. Don (Loc.-Timol, Titmulya)

Syn. *V. foetens* Decne.

Deciduous shrub with pale pink flowers and purple fruits. Deokhuri, 2700 m. July 1984 (4519).

Boraginaceae

Borreria stricta Linn.

Small erect herb with white flowers. Reeh, 1700 m. June 1984 (883).

Hymnopogon parasiticus Wall.

Epiphytic shrub with white flowers. Gangi, 2500 m. June 1984 (874).

Galium acutum Edgew.

Scandent glabrous herb with whitish yellow flowers and black when drying. Tamakundo, 3400 m. Sept. 1985 (3058).

G. mollugo Linn. subspp. **asperifolium** (Wall. ex Roxb.) Kitamura

Trailing herb with white flowers. Henuri, 2700 m. Aug. 1984 (1292).

G. rotundifolium Linn.
Trailing herb with white flowers. Gangi, 2500 m. July 1984 (888, 889).
Onosma emodi Wall.
Hairy herb with blue flowers. Tamakundo, 3400 m. Sept. 1985 (5739).
Rubia cordifolia Linn. var. **manjista** Miguel. (Loc.-Manjistha)
Syn. *R. cordifolia* Linn.
Climbing herb with white flowers. Reeh, 2100 m. July 1984 (1052).

VALERIANACEAE

Nardostachys grandiflora DC. (Loc.-Maansi)
Erect herb rooting in crevices of boulders with yellowish or light blue flowers. Bajloo, 3500 m. Aug. 1984 (4823).
Valeriana hardwickii Wall.
Aromatic rhizomatous herb in crevices of rocks with pinkish, white flowers. Bhumka, 3100 m. Aug. 1984 (873).
V. jatamansi Jones
Syn. *V. wallichi* DC.
Herb with white flowers. Henuri, 2700 m. June 1984 (1293).

DIPSACACEAE

Dipsacus mitis D. Don
Syn. *D. inermis* Wall.
Large hairy herb with white flowers. Kalyani, 2500 m. Aug. 1984 (687).
Morina longifolia Wall. ex DC. (Loc.-Somrus)
Large spiny herb with pale purple flowers. Kalayani, 2600 m. Aug. 1984 (687).
Triplostegia glandulifera Wall. ex DC.
Glandular small herb with yellow flowers. Saura, 2800 m. May 1984 (3086).

(*to be continued*)

NOTES ON ECOLOGICAL RELATIONSHIP IN BASKING AND NESTING SITE UTILISATION AMONG *KACHUGA* SPP. (REPTILIA, CHELONIA) AND *GAVIALIS GANGETICUS* (REPTILIA, CROCODILIA) IN NATIONAL CHAMBAL SANCTUARY[1]

R. J. Rao[2] and L. A. K. Singh[3]

(*With a text-figure*)

Availability, basking, nesting and nest losses in *Kachuga tentoria circumdata, K. kachuga* and *K. dhongoka* are described. The extent of niche separation from *G. gangeticus* are highlighted. Extension of measures for gharial management to the turtles is advocated.

Introduction

Gharial (*Gavialis gangeticus*) are sympatric with the freshwater turtle, *Trionyx gangeticus* (Annandale 1912) and some of the Emydid turtles of *Kachuga* spp. (pers. obs.). In the present study observations have been recorded to show that although freshwater turtles and gharial occupy the same habitat, their ecological niche are neatly distinct, with little overlap as regards the utilisation of basking and nesting sites. The ecological advantage experienced by the two groups because of any little overlap in the niche are also highlighted. The management implications of the study has been highlighted with the recommendation that with minimum extension of the measures already taken for gharial conservation (Singh *et al.* 1984), the hardshell turtles can also be given a better lease of life in National Chambal Sanctuary.

Methods

Observations were made from October 1983 to April 1985 along a stretch of 570 Km. of the Chambal river, under National Chambal Gharial Sanctuary (25°23′-26°52′N and 76°28′-79°01′E) (Fig. 1). Comparative observations were recorded on the behaviour of the hard-shelled turtles and Gharial in respect of selection of basking and nesting sites. These sites were marked on field map sheets and the similarities and differences were noted. Those banks were considered 'flat' where nests were situated at a height of less than 1 m above water and the bank forming an angle not less than 172.5°. Nests which were on 'gentle slopes' and 'steep slopes' where the locations had a height × distance × angle from water as 1 m and above × more than 10 m × less than 172.5°, and 1 m and above × 1-10 m × less than 172.5°, respectively.

Results

Species:

Based on collection of shells and live specimens three species of hardshell turtles were identified, namely *Kachuga tentoria circumdata, K. dhongoka* and *K. kachuga.* In a total collection of 40 shells and 18 live turtles caught in net and by hand, *K. t. circumdata* represented 60% and 66.7%, *K. dhongoka* 10% and 11.1% and *K. kachuga* 30% and

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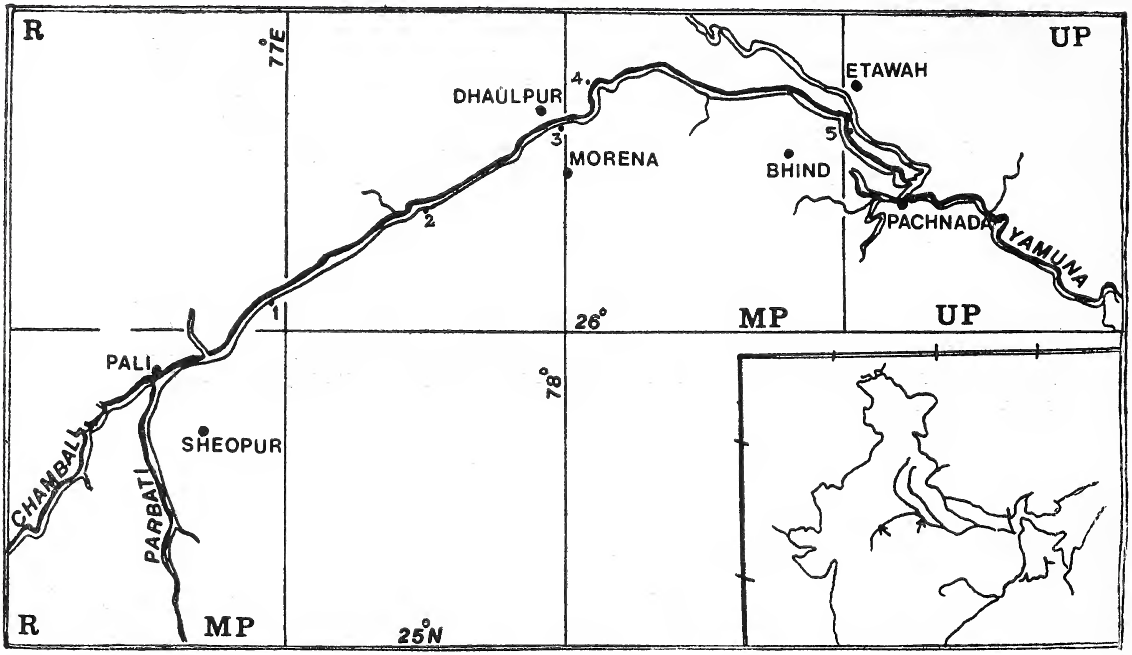

Fig. 1. National Chambal Sanctuary showing locations of gharial and turtle nesting sites referred in Table 1. The sanctuary touches the states of Rajasthan (R), Madhya Pradesh (MP) and Uttar Pradesh (UP).

22.2% respectively. On only one occasion (13 April 1985) the shell of a *Hardella thurgii* was collected. It measured 43.5 × 31.0 × 20.0 cm in straight-line carapace length × width × shell height. *K. kachuga, K. dhongoka* and *K. t. circumdata* were 56.0 × 42.5 × 22.0 cm, 48.0 × 35.0 × 17.5 cm and 26.5 × 19.5 × 12.5 cm respectively in their maximum dimension, length × width × height.

Basking behaviour:

Very often it was not possible to identify the species of a turtle when basking. Turtles above 30 cm straight-line carapace length were rarely sighted during basking. Basking posture of all the hardshelled turtles was found to be similar i.e., head raised to about 45° and all limbs stretched out when they had basked long enough and were 'relaxed'. Compared to gharial, basking turtles were easily startled when approached.

In a count of 102 instances, the hardshelled turtles mainly basked on rock-outcrops (78.43%) and rarely did they prefer to bask on hard-soil (13.72%) and sand (7.85%). However, in the case of gharial, a reverse condition was found. A majority of the gharial (98%) basked on flat mainland sand banks or sand-bars. Occasionally they basked on rock outcrops (2%) even where a sand bank was adjacent. Usually turtles and gharial basked together on sand bars and also on close-by rock outcrops.

During winter months turtles were sighted throughout the day from 0900 hrs. until 1730 hrs, beyond which basking was rare. On some-

days although the air temperature was considerably lower (12°C) than the water temperature (17°C) at 30 cm depth at 0930 hrs. the turtles came out for basking under sunlight. Similarly, basking continued until about an hour past sunset when the ambient temperature was about 17.5°C.

During summer basking was less. From April turtles were found basking even at 0530 hrs. when the air temperature was 27°C and water temperature 26°C. Most of the turtles retreated into water by 1130 hrs. (air temp. 39°C and water temperature 28°C). Very few turtles had hauled out a second time during the hot mid-day. Usually basking resumed in the afternoon after 1630 hrs. and they remained out beyond sunset. During the monsoon early morning basking on a bright day was as common as during the winter.

Nesting behaviour:

Nesting commenced on different dates in the various species: *K. t. circumdata* 15 October, *K. kachuga* 13 December, *K. dhongoka* 17 December and Gharial 27 March. However, the peak nesting season of the large turtles (*K. kachuga* and *K. dhongoka*) and the Gharial was March-April, while embryo development in the early nesters commenced only during March with the conclusion of the winter months. There was a clear indication of progression of the nesting activity from the south to north which in this instance was from upstream to downstream.

Common nesting sites of gharial and turtles along the Chambal river are shown in Table 1. All nesting banks of the gharial were also used by nesting females of all three turtle species. Both turtles and gharial were communal hole nesters, preferring large sand banks. The order of use of sand banks for nesting by the gharial and turtles was as follows:

Gharial: Steep slope (83.7%) — Gentle slope (16.3%) — Flat (0%).

Turtles: Flat (69.83%) — Gentle slope (25%) — Steep slope (5.16%).

Nests of gharial were located 1 to 2 m above the water level and upto 8 m away from water. Turtle nests were located 0.5 to 2 m above the water level and 3 to 60 m away from water. However, two nests of *K. dhongoka* were at only 0.2 m height × 1.0 m distance and 5 m height × 200 m distance in relation to water. Generally, nests of *K. t. circumdata* were farther from water compared to *K. kachuga* and *K. dhongoka* (unpublished observ.).

Nest chambers of gharial and turtles were similar in design but different in size. Mean diameter & depth (cm) of the egg-clutch surface below the ground were: Gharial: 28 × 40, *K. kachuga*: 15.0 × 34.6, *K. dhongoka*: 14.7 × 21.5 and *K. t. circumdata*: 7.8 × 16.1. Similarly, although the shape of the eggs was similar, the sizes were different. Mean length (cm) × breadth (cm) × weight (g) of the eggs were: Gharial: 8.7 × 5.9 × 176.0, *K. kachuga*: 7.0 × 4.1 × 57.4, *K. dhongoka*: 5.9 × 3.6 × 44.2 and *K. t. circumdata*: 4.7 × 2.7 × 21.4.

Nest loss:

Out of a total of 1296 nests on which information was collected only 13 nests were of *K. kachuga*, 249 of *K. dhongoka* and the rest 1034 were of *K. t. circumdata.* Predation of turtle eggs was only on the main-land where predators (jackals) can easily locate the nests but nests on islands were safe except occasional instances where storks (black-necked or white-necked) had opened and predated *K. tentoria* nests. During 1-15 May, 1985 there was an increase of 1.2 m of water due to release from the Kota barrage which flooded a number of island nests of large hardshelled turtles (*K. kachuga* and *K. dhongoka*). Losses of nests occurred due to flooding (1.92%) and predation (88.1%). In the case of *K. kachuga* flooding occurred in 7.7% and preda-

TABLE 1

COMMON NESTING SITES OF GHARIAL AND HARD-SHELL TURTLES IN THE CHAMBAL RIVER

Sl. No.	Name	Distance Kms*	Description	Remarks
1.	Baroli	57	Open sand bank (Madhya Pradesh)	Heavy predation of turtle eggs. Protection to gharial eggs provided by State Forest Department.
2.	Bharrah	131	Small rocky island with alluvial deposits	Only gharial nests on this Island. Turtle nests on the sand bank on Madhya Pradesh side. Turtle eggs heavily predated. No predation of gharial eggs on the Island.
3.	Tigri-Rithaura	200	Small rocky Island with alluvial deposits	No predation.
4.	Pureini	229	Open sand bank (Rajasthan)	Turtle eggs partly predated, flooded and exposed due to agricultural practices. Gharial eggs protected.
5.	Gyanpura	363	Open sand bank (Madhya Pradesh)	Turtle eggs predated. Gharial eggs protected.

* In reference to Palighat (Parbati–Chambal confluence).

tion in 38.5%. In *K. dhongoka* and *K. t. circumdata* the respective figures were 9.6%: 60.2% and 0%:95.4%. Prevention of predation of mainland nests (5%) was mostly due to timely intervention by us or other management authorities. Some predation had occurred subsequent to exposure of the nests during ploughing for agricultural purposes. One serious instance was the exposure of 6 out of 58 nests (10.3%) at Babu Singh Ka Gher and Pureini during 1984-85.

Seven hundred and twenty (55.5%) of 1296 nests either overlapped or were within 1.5 km of a major gharial nesting site in a total 570 km of river length.

DISCUSSION

Studies in the recent past (Singh 1978, Choudhury 1981) give fairly clear accounts on the basking and nesting ecology of the gharial. Similar information on the ecology of Indian freshwater turtles (for e.g. see, Smith 1931, Pritchard 1979 and Daniel 1983) is relatively scant. Therefore, there is very little scope for us to compare our observations and draw any hard core conclusions. However, the indications that the gharial and the different *Kachuga* spp. occupy different niches within the same habitat, are worth discussions.

1. *Basking sites*: There is a clear indication in the reversal of preference order for the basking sites in both turtles and gharial. This may be due to the 'camouflage' required by the animal in respect of its basking ground. While a rocky background matches the turtles to appear like another piece of rock or a rocky-extension, gharial merges with the sandy backdrop and may even appear like a piece of drift-wood. Even when a gharial basks on slopy flat rock, the colour matches the dark background (Singh 1978).

Islands, sand bars and half-exposed rocks are preferred for basking because the depth

of water immediately underneath is suitable for a quick retreat in response to potential threats.

Sharing of a basking site by both turtles and gharial is always advantageous to the gharial because turtles are more wary and on the advent of any danger 'drop' into water first and thereby alert the gharial. The possible advantage the turtles get from the gharial by sharing the same stretch of river is perhaps by scavenging the bits of food left when a gharial chops and swallows a prey.

2. *Nesting season and site*: The same river stretch may be used by all turtles and the gharial for nesting, and even the nesting season of the large turtles and gharial coincide yet on the basis of our data there is evidence that apparently no conflict exist in the habitat utilisation. Inspite of a high nesting density in certain areas we have no evidence that the nest of one species was exhumed by another

a. The small turtles (*K. t. circumdata*) are capable of undertaking long-distance movements (Rao and Singh 1984, Singh 1985). Hence, early in the season they nest far away from the water and leave the strip adjacent to water for the more heavy and large turtles (*K. kachuga* and *K. dhongoka*).

b. The preference of a high site for nesting by gharial is well studied and related to the advent of monsoon floods during or after hatching (Singh 1978). In the turtles too one would expect that the selection of the nesting site is governed to increase the survival value of the hatchlings. However, the height-preference seem to have been overlooked as a majority of the hard-shelled turtles are not only laying the eggs on flat banks but also close to water. However, if a majority of the eggs are laid at least 60 cm or above the water level the hatchlings are fairly safe from any natural rise in water due to summer rain. In the recent years, however, such ecological adaptations have been upset due to untimely releases of water through a series of three dams and one barrage along the Chambal river. As noted earlier, 1.92% of the nests are lost due to flooding.

3. *Extension of gharial conservation measures to turtles*: Rehabilitation schemes were taken up in Rajasthan, M.P. and U.P. to protect the endangered gharial in the Chambal river by collection of wild eggs, and hatching and rearing the hatchlings to a certain size for release in the wild habitat. However, this is not in practice in case of turtle eggs. Although there is a heavy loss of turtle eggs close to sites where gharial eggs are well protected, it has to be accepted that the management attitude towards the former is more of indifference. Through the present study there has been a preliminary highlight on the ecological niche separation among the gharial and the freshwater chelonians in the Chambal. It is hoped that this will stimulate effective protective measures for turtle management. These measures should immediately be in the form of shifting of eggs from the original nests to a new well protected adjacent site. This, if carried out with usual precautions, will ensure prevention of loss due to predation, and exposure due to ploughing and flooding, by almost 100 per cent.

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STATUS OF WILDLIFE AND HABITAT CONSERVATION IN ANDHRA PRADESH[1]

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(*With two plates & two text-figures*)

This paper describes certain major and conspicuous faunal groups and habitats in the State of Andhra Pradesh.

The State is endowed with diverse habitats such as wetlands of Kolleru and Pulicat, mangroves of Coringa, rich coastal lands, dry, grass and arid lands of Deccan plateau, humid moist deciduous forests of the northern Eastern-ghats and dry deciduous forests of Nallamalais. Consequently, rich diversity of plants, and animals occurs. However, as every where else in the country, the habitats such as forests, wetlands and grass lands are fast deteriorating and consequently, the fauna and flora are highly threatened in most parts of the State.

This report is based on travels and observations made over the last two decades and gives a general picture of the situation and is not claimed to be exhaustive and comprehensive. We hope that in the not too distant future, other naturalists can take up a more elaborate and detailed status study, which is urgently required for each of the districts in the State.

Location, Physiography and Climate

Andhra Pradesh (12°37′–19°54′ N lat. and 76°46′–84°46′ E long.) is the fifth largest State in the country in terms of land area, with a spread of 27.5 million hectares. The eastern boundary, facing the Bay of Bengal, is a 970 km long coast line. The state can be roughly divided into the following three distinct and major physiographic regions:

(1) Coastal plains, bordering the coast from Srikakulam in the north to Nellore in the south. The soils are rich coastal alluvial and red. Two major river deltas, Krishna and Godavari form the rich agricultural base.

(2) The Eastern-ghats region consists of a series of broken hills and ridges of varying elevations. They are roughly divided into northern and southern sections separated by a delta of about 130 km wide in the middle. The ghats in the south are generally known as the Sheshachalam ranges.

(3) Deccan plateau covers the entire Rayalaseema and Telangana region. The terrain is generally rocky with several outcrops, with red sandy or black cotton soils.

Climatically, the coastal belt is humid while the Deccan plateau is semi-arid to arid. The annual rainfall ranges from 500 mm in the

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south-western parts of the State to 1400 mm in the north-eastern areas like Srikakulam district — with an average of 890 mm. Nearly 70% of the total rainfall is received during south-west monsoon and 20% during north-east monsoon.

Rice, sugarcane, groundnut, tobacco, chilli, cotton, millets, maize and sorghum are the principal agricultural crops. Mango, cashew-nut and coconut are the major plantation crops. There are good water sources, specially in the coastal districts. They include three major river systems: Godavari, Krishna and Pennar. Large dams such as Nagarjunasagar, Srisailam, Tungabhadra, with their network of canals, besides several smaller reservoirs, lakes and tanks provide irrigation water.

The total geo area of the State is 2,75,068 sq km, of which 63,771 sq km is under forests (Fig. 1). The State has a total population of

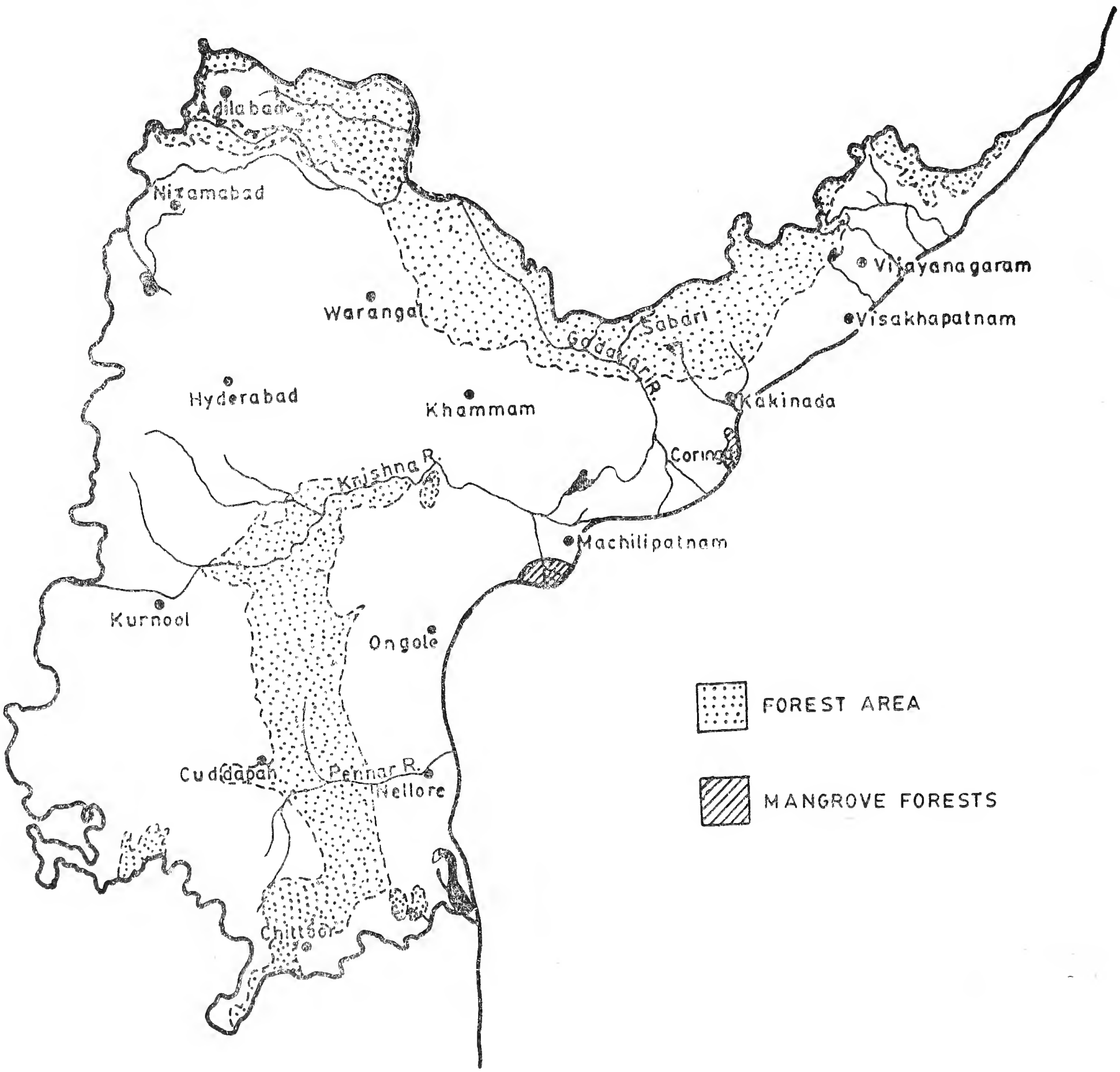


Fig. 1. Map of Andhra Pradesh showing the present well forested areas (Approximate).

535 lakhs, of which 410 lakhs is urban and 125 is rural—with a density of 195 per sq km. There are 27,221 villages and 255 towns and cities in 23 districts. Per capita forest area is 0.12 ha as against per capita land area of 0.51 ha. Total livestock is 357.40 lakhs, of which cattle, buffaloes, sheep and goat constitute a total of 306.32 lakhs.

WILDLIFE:

Forest Wealth:

The predominent vegetation in about 70% of the State forests is deciduous type; of which 45% is tropical dry deciduous and 25% moist deciduous and another 25% southern tropical thorn forests. Littoral and mangrove forests together constitute 5%. About 47 sq km area is under sal (*Shorea robusta*) and 9145 sq km is under teak (*Tectona grandis*) with the rest under mixed, miscellaneous tree species (Table 1).

The major floristic components are *Xylia — Terminalia — Anogeissus — Dendrocalamus*) (Plate 1), with second storey of *Chloroxylon — Pterospermum — Bridelia — Manilkara* species in most of the areas. Few evergreen species such as *Diospyros perigrina, D. sylvatica, Garcinia indica, Litsea chinensis* mixed with other deciduous species appear along the perennial streams in the deep valleys at higher elevations. In the Deccan plateau and other degraded forests of Telangana and Rayalaseema region, thorny-scrub type of vegetation predominates. *Prosopis, Acacia, Zizyphus, Gymnosporia, Borassus* and *Phoenix* are the major genera. In the mangroves *Avicennia, Excoecaria, Acanthus* are common. In the plains *Pongamia, Dalbergia, Mangifera, Azadirachta, Emblica, Ficus, Borassus, Phoenix, Casuarina, Anacardium, Eucalyptus* are prominent. Rolla *et al.* (1984), Krishna Murthy (1984), Ellis (1984), give detailed accounts of the flora and forests of the State.

Significance of Floral Resources

There are several commercially useful tree species like *Tectona, Shorea, Dendrocalamus, Terminalia, Pterocarpus, Adina, Sterculia, Acacia* etc. which are well spread out. Red sanders (*Pterocarpus santalinus*) is endemic to A.P. and occurs in Cuddapah and Chittoor districts. The State is also endowed with some scientific curiosities such as *Drosera* and *Utricularia* among the insectivorous plants. *Polygala furcata, Prunus jenkinsi* which are interesting from phyto-geographic angle are also recorded in the State.

Several plant species of the Eastern Himalayan region are found in the Eastern-ghats of A.P., showing a discontinuous distribution. Orchids like *Vanilla wightiana*, germ plasm sources like *Atylosia cajanifolia* are recorded from the State. In the southern ghats of Cuddapah and Chittoor districts several rare plants like *Cycas beddomei, Terminalia pallida* are reported.

Faunal Wealth:

Very little is known about the status and distribution of amphibians and reptiles of the region (Pillai & Murthy 1984). *Rana tigerina, R. hexadactyla, R. limnocharis* and *R. crassa* are some of the common amphibians. *Bufo hololius* was recently collected from Nagarjunasagar. Golden gecko *Calodactylodes aureus* was recently discovered from Chittoor area (Daniel & Bharat Bhushan 1986). Other reptiles such as *Hemidactylus brooki, H. giganteus, Mabuya carinata, Calotes versicolor, Varanus bengalensis* are common. Among the snakes cobra, king cobra, russell's viper, green pit viper, python, ratsnake, whip snake, keelback, and krait are common.

BIRDS:

The State is endowed with a wide variety of avifauna which includes the great Indian bustard, Jerdon's Courser, lesser florican, grey pelican, several species of water fowl, waders, ducks and teals, raptors, flycatchers, warblers, babblers, game birds, woodpeckers etc. (Salim Ali 1931-32, Whistler & Kinnear 1930-37). Subsequent contributions came from Abdulali (1945, 1953), Krishna Raju (1971, 1973), Ripley *et al.* (1987), Beehler *et al.* (1987), Price (1980) which give us a deeper insight into the avifaunal resources of the State. Krishna Raju (1985) listed 300 bird species from Visakhapatnam region. Siraj Taher, from Hyderabad is presently engaged in preparing a checklist of birds of the entire State (Pers. comm.).

TABLE 1

STATISTICAL PROFILE OF A. P. FORESTS

	Land area (Sq km)	Forest area (Sq km)	% of Forest area to land area
A. REGIONAL:			
Andhra (Coastal)	92,906	19,746	21.15
Rayalaseema	67,299	14,951	22.21
Telangana	1,14,863	29,074	25.31
Total	2,75,068	63,771	23.18
B. LEGAL STATUS:			
Reserved		49,921	78.30
Protected		12,343	19.40
Unnotified		1,507	2.30
Total		63,771	100.00
C. COMPOSITION (Nonconiferous broad leaved)			
Sal		47	0.07
Teak		9,145	14.34
Others		54,579	85.59
Total		63,771	100.00
D. FOREST TYPES:			
Southern tropical thorn		16,110	25
Southern tropical moist deciduous		16,100	25
Tropical dry deciduous		28,388	45
Littoral forests		2,856	4
Mangroves		317	1
Total:		63,771	100

(SOURCE: A.P. Forests at a glance 1984-85).

Jerdon's Courser, long considered extinct has been rediscovered in 1986 near Siddavatam in Cuddapah (Bharat Bhushan 1986). The endangered great Indian bustard and lesser florican occur in the State in the Deccan plateau. The pink-headed duck, now considered extinct, was earlier recorded from the State (Abdulali 1945). Kolleru at one time was considered to be the largest breeding colony of the grey pelican in the country.

The occurrence of some bird species in the State is of Zoogeographical interest (Krishna Raju 1976, 1984). Such species include tree sparrow, Abbott's babbler (Ripley & Beehler 1985) and little spider hunter, which have been collected recently from Eastern ghats. Several species found in the State are considered to be relict fauna showing discontinuous distribution and some species show very restricted breeding range confined to the State. Several migrant passerines, waterfowl and waders pass through the State on migration.

MAMMALS :

The State has a wide variety of mammals ranging from tree shrew (*Anathana ellioti*) to tiger (*Panthera tigris*) and dolphin (*Delphinus delphis*) to Dugong (*Dugong dugon*) (Table 2).

Among the primates, bonnet macaque (*Macaca radiata*) and rhesus macaque (*Macaca mulatta*) are common, the former generally confined to the south, while the latter to the north. Common langur (*Presbytis entellus*) is seen in the northern hilly areas. Slender loris (*Loris tardigradus*) seems to occur in the forests of Chittoor district now forming part of Sri Venkateswara sanctuary.

Among the cats, leopard (*Panthera pardus*), tiger (*Panthera tigris*) and jungle cat (*Felis chaus*) are present in most districts. The common mongoose (*Herpestes edwardsi*) and small Indian civet are seen generally in the northern parts of the State.

The striped hyena (*Hyaena hyaena*) is still the common scavenger in the countryside. Indian wolf (*Canis lupus*) is now confined to deccan plateau (Anantapur, Karimnagar, Mahaboobnagar areas) though there were reports from Visakhapatnam including present Vizianagaram district till 1970. These two animals created havoc by resorting to lifting of children in 1980-81. The jackal (*Canis aureus*) is still very common all over the State, while the fox (*Vulpes bengalensis*) is relatively rare.

Indian wild dog (*Cuon alpinus*) is seen in almost all the forest districts, particularly in the Eastern-ghat ranges. Their numbers have been relatively reduced over the years. Ratel (*Mellivora capensis*) is found mostly in Visakhapatnam-Vizianagaram forests. The sloth bear (*Melursus ursinus*) is very common in the State. In the recent past, reports appeared of their attack on humans in northern circar districts — and at least 20-30 maulings occur every year. Porcupine (*Hystrix indica*) occurs in all districts in suitable habitats. The Indian hare (*Lepus nigricollis*) is equally common, though there has been great reduction in their numbers.

Indian gaur (*Bos gaurus*) is distributed in the well forested tracts of Visakhapatnam, East Godavari, West Godavari, Khammam, Warangal, Karimnagar and Adilabad districts.

The chinkara (*Gazella gazella*) is confined to the north-western parts of the State mostly to the districts of Khammam, Adilabad and the surrounding areas. The blackbuck *Antilope cervicapra* occurs mostly in the plains of Deccan and North-western districts and on some islands of the river Godavari. Chowsingha (*Tetracerus quadricornis*) is common in the forests of Visakhapatnam and Vizianagaram, while nilgai (*Boselaphus tragocamelus*), in the

TABLE 2

LIST OF SOME COMMON ANIMALS OF ANDHRA PRADESH

Sl. No.	English Name	Latin Name	Vernacular Name (Telugu)
1.	Tree Shrew	*Anathana ellioti*	—
2.	Ratel	*Mellivora capensis*	Tirru Elugu
3.	Rhesus monkey	*Macaca mulatta*	Kothi
4.	Bonnet monkey	*M. radiata*	Kothi
5.	Common langur	*Presbytis entellus*	Anu pothu
6.	Tiger	*Panthera tigris*	Pedda puli
7.	Leopard	*P. pardus*	Sindhuvu
8.	Jungle cat	*Felis chaus*	Bakuru billi
9.	Hyena	*Hyaena hyaena*	Dummula gondi
10.	Wolf	*Canis lupus*	Pedda nakka
11.	Jackal	*C. aureus*	Nakka
12.	Indian fox	*Vulpes bengalensis*	Chinna nakka
13.	Wild dog	*Cuon alpinus*	Resu kukka
14.	Sloth bear	*Melursus ursinus*	Elugu banti
15.	Porcupine	*Hystrix indica*	Mulla pandi
16.	Indian hare	*Lepus nigricollis*	Chevula pilli
17.	Sambar	*Cervus unicolor*	Kanuju
18.	Indian gaur	*Bos gaurus*	Bison/Anubothu
19.	Spotted deer	*Cervus axis*	Duppi
20.	Barking deer	*Muntiacus muntjak*	Konda meka
21.	Chowsingha	*Tetraceros quadricornis*	Bayata meka
22.	Chinkara	*Gazella gazella*	Burra jinka
23.	Nilgai	*Bosephalus tragocamelus*	Manu meka
24.	Slender loris	*Loris tardigradus*	—
25.	Small Indian civet	*Viverricula indica*	Boothu billi/Manu billi
26.	Black buck	*Antilope cervicapra*	Krishna jinka
27.	Pangolin	*Manis crassicaudata*	Alugu

forests of Khammam, Adilabad, Nalgonda and in Nallamalais.

Among the deer, the sambar (*Cervus unicolor*), spotted deer (*Cervus axis*) and barking deer (*Muntiacus muntjak*) are common in forest habitats. Mouse deer (*Tragulus meminna*) is mostly seen in Vizianagaram forests.

The wildboar (*Sus scrofa*) is the commonest wild animal in the entire State. Till 1960s the wild buffalo (*Bubalus bubalis*) roamed in the forests of Sileru/Guntawada areas in Visakhapatnam district, but has now retreated to the Bastar forests of Madhya Pradesh.

A small herd of elephants (*Elephas maximus*) appeared recently in the forests of Chit-

toor district, and a lone tusker strayed into Srikakulam forests.

SANCTUARIES :

The State has 15 wildlife sanctuaries (Table 3) and 5 deer parks. Ten of these sanctuaries are located along the Godavari river system including the three in the Eastern-ghats region (Papikonda, Nagarjunasagar-Srisailam and Venkateswara), and four along the east coast (Kolleru, Coringa, Nelapattu and Pulicat) (Figure 2).

The sanctuaries constituted first in the State were Pakhal and Pocharam in Warangal and Medak districts in 1952 under the Hyderabad forest Act. Eturnagaram (Warangal district), Kawal (Adilabad) were declared in 1965 under A.P. Forest Act. Kolleru was declared in 1963. The Indian wildlife (Protection) Act, 1972 was extended to the State in 1973, under which the existing five sanctuaries

TABLE 3

LIST OF WILDLIFE SANCTUARIES AND MAJOR FAUNA — IN A.P.

	Name	District	Area (Sq km)	in the year Established	Major animals
1.	Kawal Sanctuary	Adilabad	893	1965	Tiger, Leopard, Sambar, Spotted deer, Indian Gaur, Nilgai.
2.	Pranahita Sanctuary	,,	136	1980	Tiger, Leopard, Spotted deer, Blackbuck, Sloth bear.
3.	Lanjamadugu Sanctuary	,,	36	1978	Largest Tiger reserve in India.
4.	Nagarjunasagar-Srisailam Sanctuary	Guntur, Prakasam, Kurnool, Mahaboobnagar, Nalgonda	3268	1978	Tiger, Leopard, Sloth Bear, Wildboar, Spotted deer, Sambar, Nilgai, Chowsingha, Jackal, Fox, Mugger.
5.	Manjira Sanctuary	Medak	20	1978	Marsh Crocodile
6.	Pulicat Sanctuary	Nellolr	600	—	Pelican, Flamingo and migrant water birds.
7.	Coringa Sanctuary	East Godavari	235	1978	Estuarine Crocodile, Otter, Jackals, Sea turtle, Waders etc.
8.	Kinnerasani Sanctuary	Khammam	655	1977	Tiger, Leopard, Sambar, Spotted deer, Wild-dog, Hyaena, Blackbuck.
9.	Eturnagaram	Warangal	800	1953	Tiger, Panther, Sloth bear, Gaur, Nilgai, Chowsingha, Muntjac.
10.	Nelapattu Sanctuary	Nellor	—	—	Grey Pelican nests on 14-15 Barringtonia trees, Cormorants, White
11.	Kolleru Sanctuary	West Godavari	670	1963	Ibis etc. Water birds.
12.	Pocharam Sanctuary	Medak/Nizamabad	130	1952	Panther, Sloth bear, Spotted deer.
13.	Sri Venkateswara Wildlife Sanctuary	Cuddapah Chittoor	506	1986	Panther, Jackal, Fox, Sloth bear, Nilgai, Mouse deer.
14.	Pakhal Wildlife Sanctuary	Warangal	860	1952	Tiger, Panther, Sloth bear, Gaur.
15.	Papikonda Wildlife Sanctuary	West Godavari	590	1978	Tiger, Panther, Gaur, Fourhorned antelope.

Fig. 2. Andhra Pradesh showing approximate location of the Eastern ghats, *important wildlife sanctuaries including those to be declared soon.*

were covered under section 66 in 1976. Nelapattu and Pulicat sanctuaries (Nellore district) were declared in 1977 along with Kinnerasani sanctuary (Khammam district). Five more sanctuaries: Nagarjunasagar-Srisailam, Manjira, Papikonda, Lanjemadugu and Coringa were constituted in 1978. In 1980 Pranahita was declared. In 1986 Sri Venkateswara sanctuary was declared in Chittoor district.

Population of Major Animals:

It is unfortunate that except for tiger, there are no population estimates for any major animal groups in the State. There are reportedly 164 tigers in the State including 65 in Srisailam Tiger Project as per the Forest Department Statistics. Subba Rao *et al.* (1984) stated that a population of 66 Indian gaur exists in and around Marripakala in Visakha-

patnam forest circle. A population of 30-40 Great Indian bustards is reported by the Forest Department from Nandikotkur taluk in Kurnool district. At the central Crocodile rearing station, Hyderabad, 385 muggers, 20 salt water Crocodiles and 28 gharials have been reared so far, of these 154 muggers have been released back into the Krishna river (Nagarjunasagar-Srisailam sanctuary), 15 in Pakhal lake, 33 in Kinnerasani reservoir. Three salt water Crocodiles were released in Coringa sanctuary. The muggers released in 1977 at Ethipothala have reportedly bred during 1981.

HABITAT, CONSERVATION AND GENERAL OBSERVATIONS

The Eastern ghats:

The Eastern-ghats in the state running almost parallel to the coast as a broken chain of mountains, are divisible into two distinct sub-zones. The northern sub-zone consists of the hills of Srikakulam down south to the Godavari river along the districts of Vizianagaram, Visakhapatnam, East and West Godavari districts. After a gap of nearly 130 km the southern sub-zone commences and includes the hills of Nallamalais and Seshachalam. The southern hills are better known as the Seshachalam ranges. These together with the Nallamalais, Velikondas, Palakondas, Yerramalais and Lankamalais form the Eastern-ghats complex in southern Andhra Pradesh. The southern sub-zone is generally of drier formation with inferior dry-deciduous forests and thorny scrub, while the northern sub-zone is relatively richer with forests of dry and moist deciduous types and with higher rainfall.

The forests of the Eastern-ghats account for *c.* 50% of the total state forests. These are being exploited incessantly and are getting opened up day-by-day in the name of development, often illegally. Most of the hills and once luxuriant valleys are stripped bare as in the case of Chintapalli plateau and Anantagiri-Araku (Plate 2) valley during the last quarter of the present century. Many vital rivers and reservoirs are fast getting silted up overgrazed and highly degraded with conse- (Plate 1). Vast areas of forest land are quent soil erosion in most of the areas. Illegal encroachments for shifting cultivation are widespread. All this naturally affects not only the local faunal populations but also the tribals and the total ecology of the region. Large birds such as pea fowl, jungle fowl, partridges, quails and hornbills, and mammals have either disappeared from large areas or retreated to few patches of sheltered forests.

In response to the appeals made by the Andhra Pradesh Natural History Society and thanks to the intervention of Dr. Salim Ali, the Department of Environment, Government of India organised a National Seminar on the Resources, Development and Environment of the Eastern-ghats, during March 1982 in the Andhra University, Waltair, to take stock of the situation. Coinciding with the seminar, Andhra Pradesh Natural History Society brought out a report (Krishna Raju 1982) on the ecological survey of the Eastern ghats, based on a study funded by the World Wildlife Fund-India. This was the beginning of our organised efforts to conserve the Eastern ghats. The Seminar recognised that the ghats and the adjoining wetlands are under severe environmental stress and many natural resources therein are not being managed on sound ecological principles to ensure sustainable yields. Several recommendations were made at the Seminar stressing the need to arrest further deterioration of the situation and to restore the required ecological balance. However, so far no serious attempts have been made by the Government to launch a concrete conser-

vation action except sponsoring some research projects. The need to generate additional data base is no doubt unquestionable, but if the efforts to safeguard the ghats are to begin with studies on tectonics or water quality, one has serious doubts on the wisdom of fixing priorities. Based on the data available, an action plan spelling out necessary executive and legislative actions and restoration steps, is to be chalked out and launched for implementation. Additional researches should of course be initiated simultaneously and the resultant answers used to modify and to better the ongoing conservation plan. This approach would be more useful and is urgently required in the Eastern-ghats areas and it is hoped that the Government would re-examine its approach, keeping in mind the fact that we are fighting a battle against time. The few surviving pairs of Tree Sparrow or Indian gaur may not last long.

Wet-Lands:

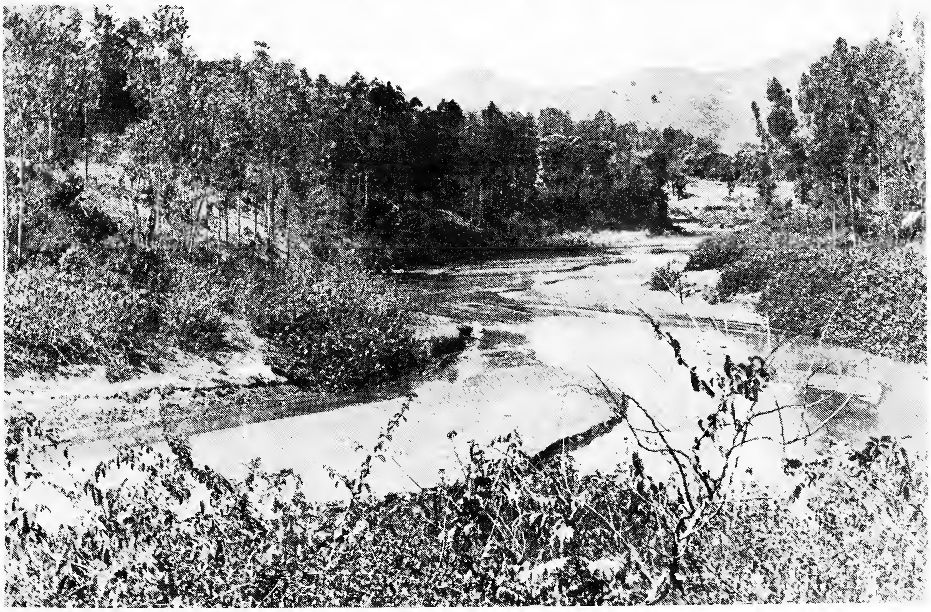
Among the wet-lands of Andhra Pradesh, Kolleru lake is the largest fresh water lake in the State, occupying parts of the East Godavari and Krishna districts. It assumed significance with the discovery of the largest breeding colony of grey pelicans (*Pelecanus philippensis*) in the early 1960s (Neelakantan 1961).

The Indian Board for Wildlife recommended the protection of pelicans at Kolleru and the Andhra Pradesh Government had subsequently declared it as a bird sanctuary in 1963. However, for various reasons the pelicans have virtually disappeared now. Over exploitation of fish resources, damage to the nesting trees, lack of adequate and suitable nest building material, heavy poaching, polluted water among other things must have forced the pelicans to abandon the area. However, the lake still attracts a good number and variety of migratory ducks and waders and other breeding birds such as jacanas, moorhen. The lake is getting silted up fast with consequent loss of flood absorption capacity, which is directly related to the loss of vegetative cover in the catchment area. Vast areas of the lake have been encroached upon for agriculture and aquaculture and free flow of water is affected in a major portion of the lake due to ill conceived network of roads, creation of fish tanks, etc., which are also affecting the lake and its ecosystem. Added to these are the effluents drained out into the lake by several industries including a pesticide, a paper and a milk processing factories.

We reckon that it is virtually impossible to reattract the lost pelicans at Kolleru. Instead, the existing breeding birds and visiting migrants should at least be protected and the lake ecosystem safeguarded. Overexploitation of fishery resources like *Anabas* and *Heteropneustes* requires to be controlled and eutrophication of the lake needs to be checked. The developmental plans conceived by the State Government and being implemented by the Kolleru Lake Development Board should therefore be directed to ensure a healthier environment of the lake and to protect its valuable birdlife, besides other things.

Another important wetland in northern Andhra is Kondakarla lake near Anakapalli in Visakhapatnam district. This is fed by a channel from river Sarada. This 600 ha lake is famous for its waterfowl. The only record of pink-headed duck in the State was from this lake. Though bereft of any standing vegetation, the lake still attracts thousands of migrant ducks and dozens of flamingoes every year. The State Government plans to declare this a bird preserved and has appointed a watcher, but poaching still continues.

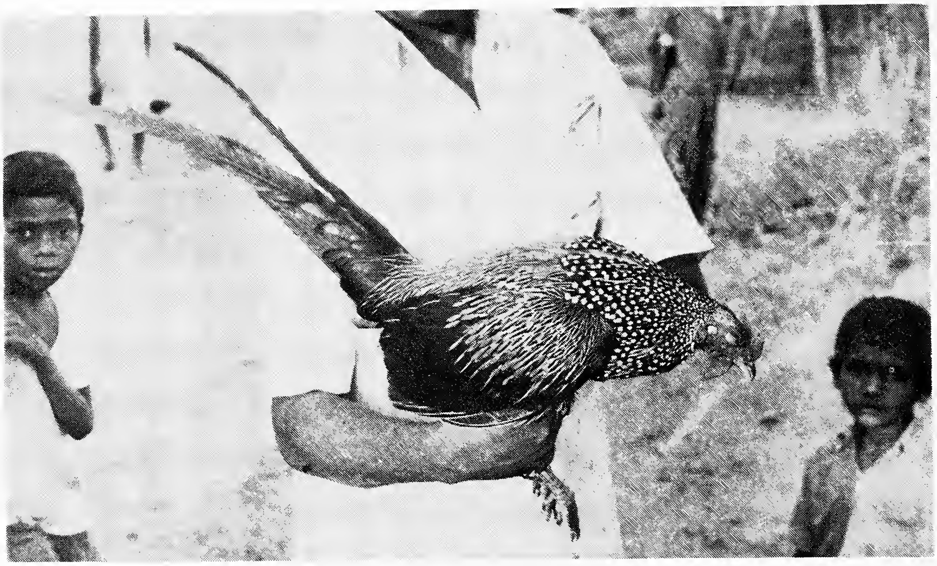
Nelapattu sanctuary and Teli-Neelapuram bird reserve attract some breeding grey pelicans (*c.* 500 pairs), cormorants, openbilled



Above: A view of dry deciduous forest *Xylia — Adina — Anogeissus.*

Below: Sileru river in the upper reaches near Araku showing denuded hills in the background. The river bed is raising fast due to soil erosion.

(*Photos*: Author)



Above: A view of once luxurient Anantagiri — Araku Valley, looking bare. Vernay survey collected several new-subspecies of birds from this region.

Below: A confiscated Grey jungle fowl from Khammam forests, one among the estimated 10-15,000 snared illegally for smuggling, every year.

(*Photos*: Author)

storks, painted storks etc. Pulicat is another major lake system on the coast near Nellore which attracts thousands of wintering ducks and flamingoes. Bhimasinghi lake, Rolugunta lake, Pakhal lake, Fox sagar, are some other important wetlands in the State. However, most of them are either polluted, drained too much or reclaimed heavily, and have generally lost their value as ideal bird refuges. Even for the famous Kolleru bird sanctuary, no listing of birds is done in a systematic manner and it is essential to determine the bird population dynamics for any meaningful management of the sanctuary.

Sloth bear and other large animals used to be common in the entire forested part of Adilabad district are now confined to Bijjur and Birsaipet forests. Spotted deer, four horned antelope and leopard used to be common in most of the forests of Visakhapatnam district are now confined to deeper and relatively sheltered parts in the ghats. This is the case with all other districts in the State. Wildlife of Mahaboobnagar district is mostly confined to the interior Amarabad and Farhabad forests. In Medak district the important faunal areas now are around Narsapuram and Narayamkhed. Mahadevipatnam and Tadicherla blocks in Karimnagar districts, Seethampet and Tekkali areas in Srikakulam district, Parvathipuram in Vizianagaram district, Srisailam — Nagarjunasagar areas in the central Andhra Pradesh, Chittoor hills in the south, Bhadrachalam, Perantanpalli, and Koonavaram in the north are some other major faunal areas. However, poaching from Jeep using search lights and snaring by nomadic tribes did irreparable damage to the wildlife. Till 1983 at least 10-15 thousand grey jungle fowl were snared from Bhadrachalam, Manugur forests for their neck feathers which used to be smuggled out through Madras Port every year (Plate 2). Similarly, nomads operate snaring parties to capture snakes, hare, jackals, partridges, quails, etc. Their operations have slowed down now, mainly due to relative dearth of animals in the State.

The precarious position of the existing wildlife calls for adoption of some drastic steps by the Government. Firstly, the needed political will and commitment that is lacking today needs to be created, without which the officials are helpless. For example, the Telugu Ganga canal which is originally planned to run through Cuddapah district may have to be slightly realigned to save the Jerdon's Courser habitat. However, such attempts are bound to be viewed with suspicion by the politicians who are yet to appreciate that no cost is too much to save the Jerdon's Courser. Telugu Ganga is perhaps a vital scheme, but the total forest area which is going to be submerged under the Project will be about 9937.40 ha (6823.41 ha under the reservoir in Kurnool, Cuddapah and Nellore districts, and 3113.99 ha under canals in the forest divisions of Atmakur, Nandyal, Proddatur, Nellore and Chittoor).

There are proposals for setting up an export oriented bauxite project in Chintapalli area of the Visakhapatnam district. The NALCO plans to exploit the bauxite found at Jerrela near Chintapalli and the project aims at having a mining complex at Jerrela, township at Chintapalli, Wagon loading complex at K. D. Peta. The ore is to be transported through a conveyor system to K. D. Peta (a distance of about 37 km, which also requires a corridor of 20 m wide and a maintenance road of 25 m wide, all along the route) which is likely to pass through some of the virgin and excellent forest areas of Chintapalli plateau. These forests hold several important bird species such as abbott's babbler, little spider hunter, and tree sparrow. Large scale industrialisation of the Chintapalli area and consequent settlements

and problems such as over burden disposal at the mine head are therefore to be viewed with great caution. The proposed network of roads and conveyor corridor in the most important ecosystem of the Eastern-ghats may cause great damage to the ecology of the region. Parts of the area also form part of the proposed Gudem-Marripakala sanctuary, which has been under the consideration of the Andhra Pradesh Government for the last 10 years. Indian gaur, spotted deer, sambar, barking deer are still common in these areas, besides several birds. A detailed environmental survey is needed before clearing the project.

About 2200 ha of forest area is likely to be submerged under Srisailam reservoir. Added to these, the State Government has recently declared that all the interior and remote tribal areas will be connected by a network of roads and electrified. We feel that such hasty developmental planning without considering the ecological implications may affect the regions ecology and economy and prove harmful even to the tribals.

Based on the data collected by the Satellite imagery, NRSA (Anonymous 1983) concluded that the actual forest area in Andhra Pradesh is significantly lower than the estimations made through conventional methods by earlier workers and the deforestation during 1972-75 and 1980-82, with an interval of about 7 years, was alarmingly high. The State has lost 3.11% of forest area in approximately 7 years time. "To allow such a high rate of deforestation to continue is to invite ecological disaster on a large scale........", the report warned.

The general attitude of the State Government and consequently the forest department is to treat the forests as a source of revenue. Hence, hitherto emphasis has been given for production forestry, while conservation and protection forestry has been generally neglected. This had resulted in large scale clear felling of "least productive mixed natural forests" and planting of economically more "useful" species like teak and *Eucalyptus,* often, as monoculture. As a result, bird and mammal life suffered badly and with the shrinkage of natural forest cover most of them either disappeared or retreated deep into the interior forests. Teak offers virtually no useful environment for birds and possibly mammals. However, Coffee plantations in the Eastern-ghats involve the use of remnant forest overstorey and most of the existing plantations have been found to be an integrated system that is structurally and taxonomically complex. Such an artificial habitat supports a relatively wide variety and more numbers of faunal groups and is a better alternative than mono-culture teak.

The Forest Department should spell out a charter of specific objectives for each of the sanctuaries in the State. For instance at Kolleru sanctuary the objective now can be to protect the breeding and wintering birds and to develop suitable habitat, for Nagarjunasagar-Srisailam sanctuary the principal objective can be to maintain optimum number of tigers through developing a habitat conducive for the growth of adequate herbivore population etc. Once these are made, an integrated plan of action needs to be initiated to serve the primary goals. But, if plans are made to increase deer population and large scale timber extraction is also allowed simultaneously the goals can never be met. In most of the sanctuaries of the State, habitat development is urgently required and a strong research base has to be built up.

It is essential that the few remaining stretches of undisturbed tracts of forest, specially in and around Chintapalli, Jyothimamidi, Gudem, Marripakala should be declared natural reserves with complete protection from disturbance and future forestry developmental activities. If developmental

plantations are to be attempted elsewhere, they should preferably exclude teak monoculture, except in badly eroded areas. Preferred development would feature coffee plantation under maximum natural over storey, interspersed with remnant forest tracts in the Chintapalli plateau (Beehler *et al.* 1987).

In 1985 one of the authors (KSR) along with the scientists of BNHS/ZSI/ and the Smithsonian Institution visited Anantagiri — the type locality for several birds. Since the Vernay Survey, the region has been heavily 'developed' with large tracts of coffee, intensively grazed areas and much cultivation. Virtually no forest remains except in small patches and the area could be characterised as severely disturbed and the destruction of the original habitat is nearly total. The remnant patches continue to support some of the 'relict' species of great biological interest, but the populations are small, vulnerable and isolated. The forest dwelling birdlife in this region appears highly threatened. By contrast, the open country species, most of which have colonized this upland region from the plains, are abundant. "The man caused environmental dessication at Anantagiri and in some other sections is causing a faunal transition, on a local scale. The future of the forest avifauna in Visakhapatnam ghats remains in doubt" (Ripley *et al.* 1987).

It is sadly true that the data presently available in respect of wildlife resources are very meagre, but this does not necessarily mean that we should initiate bench mark studies towards wildlife conservation. Few threatened species and vulnerable areas which are already identified need to be protected, on priority basis. Rollapadu, Nandyal area for Great Indian Bustard; Reddipalli and Siddavatam along the banks of river Sagileru for Jerdon's courser, Gudem-Marripakala area for Indian gaur, Addatheegala-Jyothimamidi, Maredumilli for tiger, are but few examples. Investigations are also to be carried out on the reasons why sloth bear population is disturbed now in northern Andhra and why sambar and wildboar from Koonavaram/Perantapalli show dwarfism (Parakeratosis) and why sambar and leopard are abundant near Meliaputti/Seethampet in Srikakulam scrub jungles, despite poor habitat and heavy poaching.

Suggestions:

(1) The A. P. State should arrange to document the 'Status of the Environment' with separate chapters on wildlife and conservation.

(2) Based on the data available, a conservation strategy has to be formulated and adopted with immediate effect. While the essential principles can be rigidly framed and followed, the operations can be kept flexible for modifications — if additional data collected in future warrant any changes.

(3) There are tremendous pressures on the forest land and other wilderness areas — which are to be very carefully evaluated and the forest cover and quality need to be maintained if not improved.

(4) There is an urgent need to initiate field studies in wildlife biology in the State and status study in all the districts. We recommend experimental wildlife farming to re-stock the forests and countryside with such common species like wildboar, hare, partridge and deer.

(5) The voluntary and non-Governmental bodies have a definite and important role to play in conservation efforts and they should be taken into confidence by the State for achieving the stated goals.

(6) Our major objectives should be to initiate a developmental strategy which will be ecologically sound, sociologically acceptable and economically viable.

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ON THE SEX PROPORTIONS AND MATURITY TRENDS IN *CYNOGLOSSUS SEMIFASCIATUS* DAY ON THE WEST COAST DURING 1980-81[1]

G. SESHAPPA[2] AND B. K. CHAKRAPANI

Twenty-seven samples of *C. semifasciatus* were analysed in all for sex and maturity trends from Calicut, Cannanore, Mangalore and Malpe during the period February 1980 to January 1981, the samples being preserved and transported to Bangalore and worked out there. Two additional samples were also collected from Cochin during January 1982 and examined similarly. The Cochin samples of January 1982 resembled the Calicut samples of January 1981 in the general maturity trends of the females (only this sex being analysed for stages of maturity in this work); only the early immature and the advanced spent as well as spent recovering stages occurred in these samples, the intermediate stages (III to VI) being completely absent.

In the pooled data of the other centres no immature juveniles in stage I occurred in the first and second quarters of the year while they were dominant in the fourth quarter; the latter occurrence indicated that the main spawning had taken place at the last phase of the third quarter and early in the fourth quarter in the area, as found in past at Calicut. Spawning and post-spawning stages (VI and recovering II) were completely absent in the second quarter but occurred in the first and fourth quarters. While stage VII was more frequent in the fourth quarter, stage II (recovering) was more frequent in the first quarter.

INTRODUCTION

Some detailed work was done in the past on the sex proportions and maturity trends in *Cynoglossus semifasciatus* Day at Calicut (Seshappa and Bhimachar 1955); some further information is also available for some years on these trends in a summary way for both Calicut and Mangalore in the Annual Reports of the Central Marine Fisheries Research Institute published in the various volumes of the *Indian Journal of Fisheries.* No detailed information is available for Cannanore, but a single sample studied from Moplah bay, Cannanore (Seshappa 1978) dealt with 28 individuals collected on 14-12-1968, these including 14 females (9 of these being in stages III and above and others in stages I and II). Seshappa (1980) has given an account of the sex proportions and maturity trends in *C. bilineatus* (Lacepede) and *C. macrolepidotus* (Bleeker) at Calicut.

27 samples of *C. semifasciatus* were collected and examined between February 1980 and January 1981 (inclusive) from four selected centres of the west coast for a study of the population variations in the species in time and space; along with the selected morphometric and meristic characters that were studied in these samples the sexes were determined and maturity stages also recorded for all the females. Malpe, Mangalore, Cannanore and Calicut were the sampling centres; but the

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findings on two samples from Cochin harbour available in January 1982 are also given at the end.

While as many as 15 samples were available from Calicut, only six samples were obtained from Mangalore, five from Cannanore and only one sample from Malpe.

Methods

The mode of collection, preservation and transport of the samples to Bangalore has been given elsewhere (Seshappa and Chakrapani, in press). The sexes were determined in the preserved specimens after cutting open the abdomen and careful examination of the gonads with the necessary microscopic examination (only the females being taken up for determining the maturity stages). The key followed for designating the various stages was the one given by Seshappa and Bhimachar (1955).

Results

The dates of collection of the samples at the different places, the gears used and the total numbers of the two sexes in each sample are given in table 1. Table 2 shows the monthwise frequency and percentages of the different stages among the females of *C. semifasciatus* examined during the period. The following are the main features of the maturity trends noticed:

(a) *Malpe*: There are 18 females in the single sample examined; among these 77.78% are in stage V and three are in still higher stages of maturity while only one individual is in stage I (i.e. below V). The very high percentage of the pre-spawning advanced maturity stages is not quite normal at Calicut and they are not noticed here in April when only 7.02% are found in stage V; but in Mangalore 26.09% of the females are found in stage V; while no samples are available from Cannanore in March and April, 18.18% of the females are in stage V there, in May. Probably spawners occurred in good numbers even upto the commencement of the southwest monsoon all along the west coast in 1980; the occurrence of large numbers of stage V fish at Malpe is particularly noteworthy for March.

(b) *Mangalore*: Samples were available from this centre only during February, March and May. February showed all the maturity stages from I to VII (and spent recovering stage II also), this last bracketted stage being dominant and forming 40.9% of the total females (stage V with 22.73% being the second dominant). Stages above V were absent in March and May (except for one specimen in March in stage VII). The dominant stages in March and May were IV and III with 41.30% and 50.70% of the total females respectively. Stages II and V were the main maturity stages seen in both the months.

(c) *Cannanore*: While five samples were available from this centre, only the months of May, October and December were represented; stages III to V were seen in May with stage III dominating (60.61%) while all the 13 females of October were in stage IV; in December stages IV to VI were absent and stage VII (spent) was dominant with 40% of the females in it, while stages I to III were also present with stage I dominating the series (22.5%); these represented the new recruits that formed a distinct size group at the lower end of the series, the older fish being represented by stages VII and II (spent recovering).

(d) *Calicut*: April and May represented the premonsoon period in the samples of this place; stages above V were absent in both these months and the other stages ranged from II to V. Stage IV was dominant in April (59.65%) and stage V in May (53.49%).

TABLE 1

DETAILS OF DIFFERENT SAMPLES OF *C. semifasciatus* TAKEN FROM DIFFERENT CENTRES DURING 1980-81 ALONG WITH THE GEARS USED AND THE NUMBERS OF THE TWO SEXES (TWO SAMPLES FROM COCHIN TAKEN IN JANUARY 1982 ARE ALSO INCLUDED IN THE TABLE AT THE END)

Dates	Places	Total males	Total females	Gears used
23-2-1980	Mangalore	25	22	Trawl net
14-3-1980	,,	45	19	,,
15-3-1980	Malpe	28	18	,,
28-3-1980	Mangalore	24	27	,,
23-4-1980	Calicut	27	26	,,
30-4-1980	,,	19	30	,,
5-5-1980	Mangalore	29	25	Trawl net?
8-5-1980	Cannanore	39	14	Trawl net
10-5-1980	Calicut	33	22	,,
15-5-1980	Mangalore	30	22	Trawl net?
22-5-1980	,,	27	24	,,
25-5-1980	Calicut	28	22	Trawl net?
28-5-1980	Cannanore	32	19	,,
6-10-1980	near Cannanore	22	13	Not known
21-10-1980	Calicut	22	32	Gillnet (*ayilachalavala*)
23-10-1980	,,	29	26	Seine net (*Pattenkollivala*)
30-10-1980	,,	19	32	,,
31-10-1980	,,	27	24	Gillnet (*ayilachalavala*)
28-11-1980	,,	22	28	Seine net (*Pattenkollivala*)
1-12-1980	,,	34	18	Trawl net
13-12-1980	(i) Calicut	30	25	,,
	(ii) ,,	26	27	Seine net (*Pattenkollivala*)
14-12-1980	Cannanore	33	19	Trawl net
28-12-1980	,,	31	21	,,
29-12-1980	Calicut	19	33	,,
15-1-1981	,,	32	24	,,
28-1-1981	,,	30	23	,,
		Cochin samples of January 1982		
8-1-1982	Cochin Harbour	28	37	Shrimp trawl?
13-1-1982	,,	48	20	Shrimp trawl

The latter stage formed only 7.02% in April while stage IV formed 18.6% in May and a good proportion of the females had moved over from IV to V in this interval. October had unusually included a few juveniles of a new brood in stage I (3.51%), the range of other stages being mainly III to V with a single specimen each in stage VII and stage II (recovering spent); the dominant stage in October was IV (40.35%). The maturity stages of this month indicate that not only had spawning started already in the neighbourhood but also a few juveniles had entered the catches unusually early in the season. In November there was only one sample and all the fish in it were juveniles in stages I and II with stage I forming 82.14%. In December all stages were represented with the minimum of one each in

TABLE 2

MONTHLY TOTAL FREQUENCY AND PERCENTAGE DISTRIBUTION OF DIFFERENT MATURITY STAGES IN *C. semifasciatus*, FEBRUARY 1980 TO JANUARY 1981. (FIGURES IN BRACKETS ARE PERCENTAGES)

Months	Maturity stages								Totals
	I	II (Virgins)	III	VI	V	VI	VII	II (Recovering)	
I. MANGALORE									
February	0	3 (13.64)	1 (4.55)	2 (9.09)	5 (22.73)	1 (4.55)	1 (4.55)	9 (40.91)	22
March	0	13 (28.26)	1 (2.17)	19 (41.30)	12 (26.09)	0	1 (2.17)	0	46
May	0	2 (2.82)	36 (50.70)	27 (38.03)	6 (8.45)	0	0	0	71
II. MALPE									
March	0	1 (5.56)	0	0	14 (77.78)	2 (11.11)	1 (5.56)	0	18
III. CANNANORE									
May	0	0	20 (60.61)	7 (21.21)	6 (18.18)	0	0	0	33
October	0	0	0	13 (100%)	0	0	0	0	13
December	9 (22.50)	7 (17.50)	1 (2.50)	0	0	0	16 (40.00)	7 (17.50)	40
IV. CALICUT									
April	0	8 (14.14)	11 (19.30)	34 (59.65)	4 (7.02)	0	0	0	57
May	0	1 (2.33)	11 (25.58)	8 (18.60)	23 (53.49)	0	0	0	43
October	4 (3.51)	0	23 (20.18)	46 (40.35)	39 (34.21)	0	1 (0.88)	1 (0.88)	114
November	23 (82.14)	5 (17.86)	0	0	0	0	0	0	28
December	40 (38.83)	34 (33.01)	8 (7.77)	3 (2.91)	1 (0.97)	1 (0.97)	9 (8.74)	7 (6.80)	103
January 1981	3 (6.25)	4 (8.33)	0	0	0	0	10 (21.83)	31 (64.58)	48

stages V and VI and a maximum of 38.83% and 33.01% respectively in stages I and II; the frequency of the different stages declined after II and rose again (to 9% and 7% respectively) in stages VII and recovering II. In January, only stages I and II (6.25% and 8.33%), and VII and recovering II (21.83% and 64.58%) occurred.

X^2-ANALYSIS (TABLE 4)

The degree of disparity or otherwise of the monthly sex ratios for the different centres

were tested by means of the X^2-analysis (Snedecor and Cochran 1968). For Calicut this analysis for the different months and also for the totals of the entire period showed non-significant differences ($X^2 = 0.1161$ to 1.2308 for different months and 0.0158 for the annual totals, P being more than 0.05 and non-significant).

For Cannanore, the May values showed a X^2-value of 7.2835 with P less than 0.01 and significant, while in the other two months the difference was non-significant. The year's total at Cannanore showed a X^2-value of 10.3724 with P at about 0.001 and highly significant.

For Mangalore, the monthly distribution as well as the total sex distribution showed X^2-values ranging from 0.0957 to 2.6348 with P more than 0.05 and insignificant. For Malpe, represented by a single sample, the X^2-value was low ($= 1.0870$) with P more than 0.05 and non-significant.

Thus, only the samples of Cannanore showed an uneven distribution of the two sexes this standing out in the May totals as well as the annual totals. It is difficult to assign any reason clearly for the significant departure noticed here. But marked segregation of the sexes in individual samples and local populations may be noticed during October-November, but this being uncommon later, and particularly as late as May following (Seshappa and Bhimachar 1955). The disproportionate distribution of the sexes is usually connected with the spawning period, out-of-the-season spawning being also sometimes noticed at Calicut during recent years. It is just possible that some such phenomenon may have been responsible for the above disparity at Cannanore; as samples have been available only for the three months of May, October and December, the totals of the year only reflect the condition of the dominant one of these months. While nothing can be said on this definitely in the absence of the samples for the June-September period, it can still be said with some confidence that there is perhaps no consistent difference between or within the other centres to indicate any clear possibilities of stock differences.

Remarks

According to data published earlier for Calicut (Seshappa and Bhimachar 1955) in all the years of normal sole fishery, the shoaling starts immediately after the southwest monsoon is over, and the fish has the gonads in an advanced condition of stages IV-V of maturity by October; small juveniles of the new brood join the catches within 2-3 weeks of this and the December fishery usually consists of a large percentage of juveniles of the year (though these are usually discarded in the sea by the fishermen); spawning goes on continuously or intermittently right through the fourth quarter of the Calendar year and through the first quarter of the following year also. The new recruits entering the grounds in intermittent batches vary in numbers from time to time and are all immature, stage III of maturity appearing only in the second quarter of the year in the fish of the new brood. The gonads grow further and reach advanced pre-spawning stages by the following October-November months (after the passage of the fish through the southwest monsoon away from the inshore grounds, with a scattered distribution).

During the years before the introduction of regular trawling in the inshore waters, the phenomenon of *"Manthayilakam"* or massive shoaling up of the fish in the surface waters during September and October after the heavy rains are over, used to be noticed regularly, the fish moving away from the inshore grounds for spawning after this. It has been reported

(V. Balan, CMFR Institute, pers. communication) that this *"Manthayilakam"* is hardly noticeable these days after the introduction of trawling, the normal fishery of the October-November period also being not steadily intense (with some quantities being landed all round the year except during the monsoon months when the trawlers are also idle). Perhaps as an adaptive adjustment to these conditions the biological cycle seems to be getting modified to some extent in that out-of-the-season spawning is also noticed occasionally in some years in the monsoon months. The intensive and more or less continuous fishing perhaps provides for better growth with reduction in population strength and early maturity of the pre-monsoon populations of the fish; it has been noticed frequently in recent years that sizes larger than reported by Seshappa and Bhimachar (1955) are seen in the pre-monsoon samples of the Malabar sole at Calicut, these being still members of the "O" year class only.

It is interesting to examine the pooled quarterly data of the present work (table 3) in the light of the above observations. No samples were available for the third quarter of the year as usual, and it will be noticed that no juveniles of stage I occurred in the first and second quarters of the year though they formed the dominant group (25.50%) in the fourth quarter. This is a clear indication that the main spawning has taken place as usual either at the end of the third quarter or early in the fourth quarter. Another interesting point clearly noticed is that the spawning and post-spawning stages (i.e. stage VI to recovering stage II) are completely absent in the second quarter, while they are present in the first and fourth quarters; stage VII (spent) is more frequent in the fourth quarter (8.72%) while stage II (recovering spent) fish are more frequent in the first quarter (10.47%).

TABLE 3

POOLED QUARTERLY TOTAL FREQUENCY AND PERCENTAGE DISTRIBUTION OF THE DIFFERENT MATURITY STAGES IN FEMALE *C. semifasciatus*, DURING 1980. (FIGURES IN BRACKETS ARE PERCENTAGES)

Stages	Quarters			
	January-March	April-June	July-September	October-December
I	0	0	No data	76(25.50)
II (Virgins)	17 (19.77)	11 (5.39)	,,	46(15.44)
III	2 (2.33)	78 (38.24)	,,	32(10.74)
IV	21 (24.42)	76 (37.25)	,,	62(20.81)
V	31 (36.05)	39 (19.12)	,,	40(13.42)
VI	3 (3.49)	0	,,	1 (0.24)
VII	3 (3.49)	0	,,	26 (8.72)
II (Recovering)	9 (10.47)	0	,,	15 (5.03)
Totals:	86	204	Nil	298

TWO SAMPLES FROM COCHIN HARBOUR

Two samples of *C. semifasciatus* were available during January 1982, one on 8-1-1982 and the other on 13-1-1982. These are being treated separately from the rest as they were collected one year after the other samples treated above in this paper and hence considered unsuitable to be combined with those samples. The following are sex proportions and maturity trends noticed at Cochin in the above mentioned material:

Sample dates	Total males	Different I	II (Virgin)	Maturity III	stages among females IV	V	VI	VII	II (Rec.)	Total Females
Jan. 8	37	2 (7.14%)	11 (30.29%)	0	0	0	0	1 (3.57%)	14 (50%)	28
Jan. 13	48	4 (20%)	8 (40%)	0	0	0	0	0	8 (40%)	20

TABLE 4

MONTHLY SEX-DISTRIBUTION IN *C. semifasciatus* AT FOUR CENTRES DURING FEBRUARY 1980 to JANUARY 1981, ALONG WITH X^2-VALUES

Months	Calicut		Cannanore		Mangalore		Malpe	
	Males	Females	Males	Females	Males	Females	Males	Females
February	—		—		25	22	—	
March	—		—		69	46	28	18
April	46	56	—		—		—	
May	60	44	71	33	86	71	—	
October	97	114	22	13	—		—	
November	22	28	—		—		—	
December	109	103	64	40	—		—	
January 1981	62	47	—		—		—	
Totals:	396	392	157	86	180	139	28	18
X^2:	0.0158		10.3724		2.6348		1.0870	
P:	>0.05		0.001		>0.05		>0.05	
R:	NS		SS		NS		NS	

Abbreviations:- X^2 = Chi-square; P = Probability level; R = result i.e. whether significant or otherwise; NS = non-significant; SS = highly significant.

In both the samples, the maturing and mature (or ripe) females are completely absent and only the spent recovering and immature fish are noticed in the samples. A single specimen in stage VII (spent) was found on 8-1-82, this being absent on 13-1-82 when all the larger females (equalling 40% of the total) were recovering spent individuals. The dominant maturity stages on both the occasions were found to be II (virgin) and recovering II. This situation is closely comparable to the same occurring at Calicut in January 1981, the details of the latter being as follows:

Sample dates	Total males	Different I	II	Maturity III	stages among females IV	V	VI	VII	II (Rec.)	Total Females
Jan. 15	32	3 (12.5%)	0	0	0	0	0	9 (37.50%)	12 (50.00%)	24
Jan. 28	30	0	4 (17.39%)	0	0	0	0	1 (4.35%)	18 (78.26%)	23

In the totals of January in the above centres during the two different years, it is found that the intermediate maturity stages III to VI are completely absent and the only stages represented are I and II among the smaller sizes and VII and recovering II among the larger sizes of the fish; soles of the last mentioned stage are most dominant at both the places during the period relevant to them here.

Conclusion

The seasonal maturity trends among the females of *C. semifasciatus* follow generally the same pattern as described for the species at Calicut (Seshappa and Bhimachar 1955) with a few differences. The spawning season also appears to have been roughly the same as at Calicut in the earlier years. While individual samples showed some apparent disparity now and then between the numbers of the two sexes, X^2-analysis showed that the differences are not statistically significant when studied among monthly and annual totals except at Cannanore where a significant difference is seen during one particular month, this showing out in the annual totals also.

Acknowledgements

We are thankful to the Indian Council of Agricultural Research for grants under the Emeritus Scientists' Scheme. We are grateful to the authorities of the Central Inland Fisheries Research Institute and of its Bangalore Centre for the working facilities given to us at Bangalore. We also thank Dr. R. S. Lal Mohan, Shri M. H. Dhulkhed and Shri K. V. Narayana Rao of the Central Marine Fisheries Research Institute, and also Sarva Shri P. K. Sukumaran and S. Ayyappan of the Central Inland Fisheries Institute for help in the collection, preservation and transport of the fish samples from the west coast.

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NEW DESCRIPTIONS

TAXONOMIC STUDIES ON THE MARINE OSTRACODA FROM THE EAST COAST OF INDIA FAMILY: CYTHERURIDAE MULLER, 1894[1]

C. ANNAPURNA AND D. V. RAMA SARMA[2]

(*With three plates*)

INTRODUCTION

While investigating the systematics and ecology of benthic ostracods, 40 species belonging to 27 genera and 14 families were identified from the marginal marine/estuarine environments, namely Bimili backwaters (17°54′N, 83°28′E), Balacheruvu tidal stream (17°39′N, 83°15′E) and Vasistha Godavari estuary (16°18′N, 81°42′E). (Annapurna 1978).

Among the members of the family Cytheruridae Müller, 1894, *Paijenborchellina caudatum, P. reticulatum* are new to science, *Cytheropteron alatum* Sars, 1865 is recorded for the first time from Indian waters.

Family: CYTHERURIDAE Müller, 1894
Subfamily: CYTHERURINAE Müller, 1894
Genus: *Paijenborchellina* Kuznetsova, 1957

KEY FOR IDENTIFICATION OF SPECIES OF *Paijenborchellina*:

1. Surface ornamented with longitudinal ridges, closely spaced pits, scattered cross-bars lie between the ridges .... *Paijenborchellina* sp? 1
2. Ornamented with reticulations, pits lie between the reticulations 6
3. Four hollow tubercles present, pits arranged in rows at posterior margin 5
4. Surface of the shell densely pitted, the interspaces bluntly spinose to rugose .... *Paijenborchellina* sp.? 2
5. Amphidont type of hingement, median hinge element divided into short anteromedian and longer posteromedian elements .... *P. caudatum*
6. Amphidont type of hingement, all elements crenulated .... *P. reticulatum*

Paijenborchellina caudatum sp. nov.
(Pl. 1, Fig. A; Pl. 2, Figs. 1-7)

Shell sublanceolate in side view, highest near anterior end. Dorsal and ventral margins sinuous. Posterior margin caudate, pointed and strongly extended medially, concave below. Valves subequal, compressed. Surface of the valve ornamented by narrow, somewhat sinuous, longitudinal ridges that converge towards ends, but do not occupy posterior caudal part of shell, which is slightly compressed and smooth. Longitudinal ridges well developed in dorsal half of shell; numerous closely spaced pits and scattered cross-bars lie between ridges. Amphidont type of hingement. Median hinge element divided into short anteromedian and longer posteromedian elements. Inner lamella moderately wide. Line of concrescence and inner margin coincide throughout and run subparallel to the outer margin. Marginal pore canals few, straight, widely spaced, numerous at anterior end and few at posterior end.

Length 0.49 mm; height 0.25 mm.

Antennule 6-jointed; first four podomeres

[1] Accepted December 1985.

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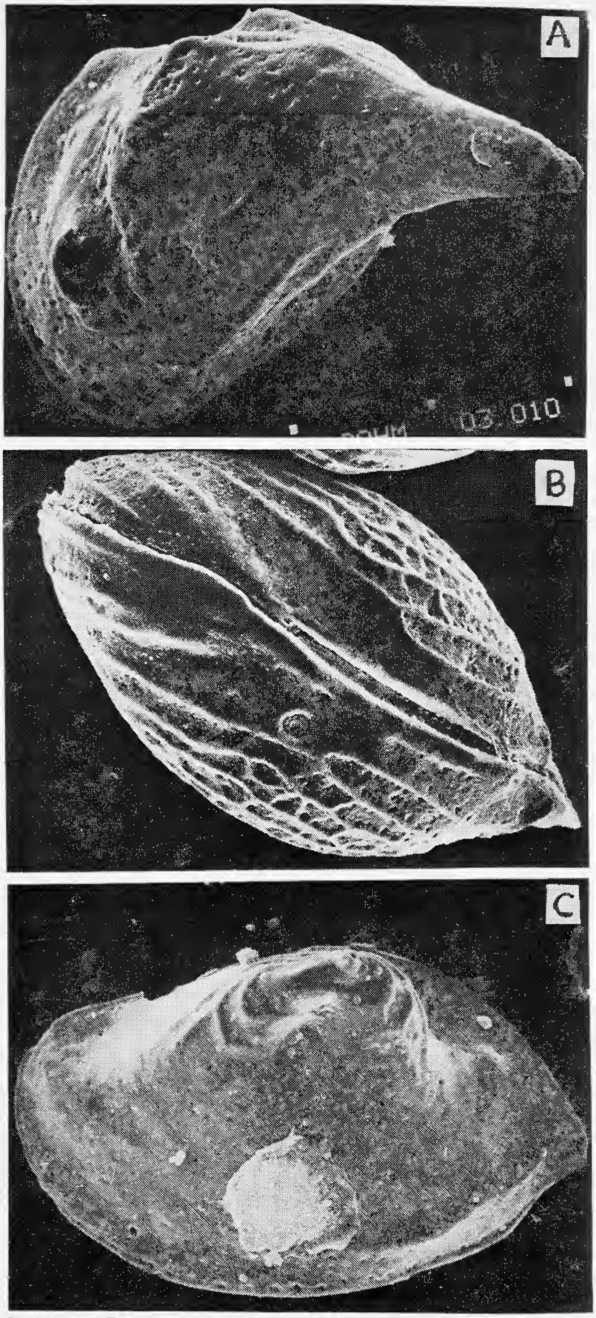
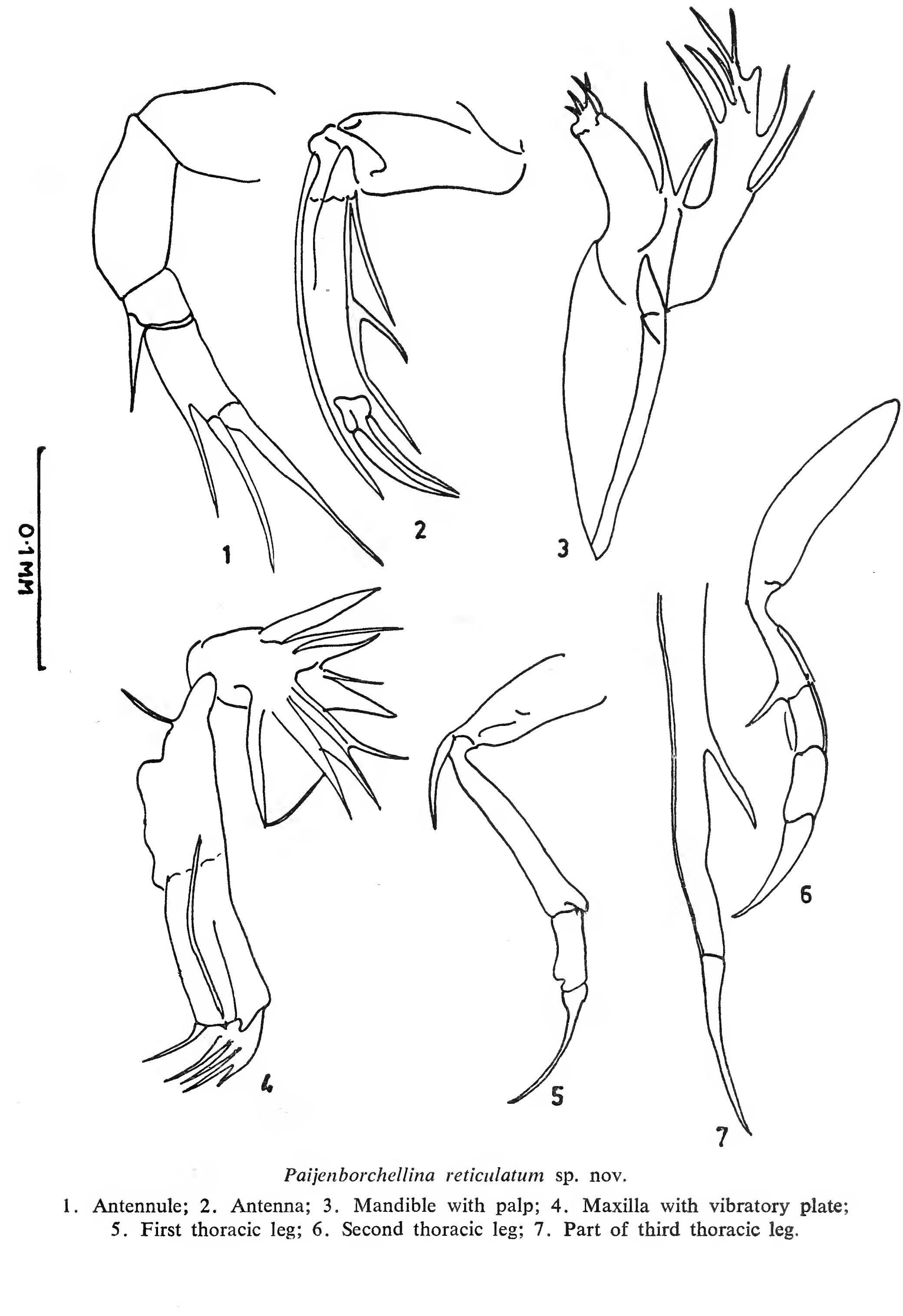


A. *Paijenborchellina caudatum* — Exterior view of left valve.

B. *P. reticulatum* — Carapace seen from above.

C. *Cytheropteron alatum* — Exterior view of carapace.

Annapurna & Rama Sarma: Marine Ostracoda



Paijenborchellina reticulatum sp. nov.

1. Antennule; 2. Antenna; 3. Mandible with palp; 4. Maxilla with vibratory plate; 5. First thoracic leg; 6. Second thoracic leg; 7. Part of third thoracic leg.

Paijenborchellina caudatum sp. nov.

1. Antennule; 2. Antenna; 3. Mandible with palp; 4. Vibratory plate; 5. Maxilla; 6. Third thoracic leg; 7. Second thoracic leg.

long and broad, without any bristles. Penultimate podomere shorter than remaining podomeres and bears single anterior seta. Ultimate podomere ends with 2 claw-like setae and single anterior seta. Antenna 4-jointed, first podomere long and broad, second and third podomeres narrow, each with single anterior seta, ultimate podomere with two claw-like terminal setae and one additional slender seta. Mandible with 4 serrate teeth laterally placed on cutting area. Mandibular palp 4-jointed. First segment with 2 elongated setae, second segment with one elongated seta. Penultimate joint with 2 anterior and 2 posterior elongated setae, the ultimate segment ends with 2 claw-like setae and 2 bristles on either side. Maxilla with 3 elongate masticatory lobes; ends with group of setae. Vibratory plate bearing 15 unfeathered rays. First thoracic leg 3-jointed, ending in curved claws; distal end of first podomere bearing 1 seta and of second podomere longer than remaining ones. Second thoracic leg 4-jointed, ending in curved claws. First podomere longer and elongated than other podomeres. Second podomere with single seta. Third thoracic leg 3-jointed ending in curved claws. Distal ends of first and second podomeres bear seta. Paired eyes clearly visible in living conditions. Male and female differentiated by the size and genital organs.

Remarks: In the general shape, arrangement of radial pore canals and in the marginal outline *P. caudatum* is similar to *Paijenborchellina* sp.? 1 and *Paijenborchellina* sp.? 2, as illustrated by Reyment, 1959. It differs from the above species in the presence of hollow tubercles in the anterior two-thirds of the body. Posterior marginal pits present in rows. But in other species they are scattered. Pits uncommon on the extreme part of the body. The species name is based on the pronounced nature of caudal process at the posterior side.

Type-locality: Backwaters of Bimili, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the collections of Zoological Survey of India, Calcutta, India.

Occurrence: Backwaters of Bimili and Balacheruvu tidal stream, East coast of India.

Paijenborchellina reticulatum sp. nov.

(Pl. 1, Fig. B; Pl. 3, Figs. 1-7)

In lateral view the carapace is ovate, wedge shaped to pear shaped. Anterior margin broadly rounded, posterior margin pointed. Valves subequal, compressed. Surface of the valves ornamented with reticulations. Pits arranged in reticulations. Hinge amphidont type, the median hinge element crenulated. Inner lamella moderately wide. Marginal pore canals few, straight, widely spaced, numerous at anterior end, few at posterior. Length 0.61 mm; height 0.37 mm.

Antennule 6-jointed, first four podomeres long and broad without any bristles, penultimate podomere shorter than remaining podomeres and bears single anterior seta. Ultimate podomere ends with 2 claw-like setae and single anterior seta. Antenna 4-jointed, first podomere long and broad, second and third podomeres narrow and each podomere bears a single anterior seta. Ultimate podomere with two claw-like setae and one additional slender seta. Mandible with 6 serrate teeth laterally placed on cutting area. Mandibular palp 4-jointed, first segment with 2 elongated setae, second with one elongated seta. Penultimate joint broad with two anterior and two posterior elongated setae, the ultimate segment ends with two claw-like setae and two bristles on either side. Maxilla consists of two elongated

masticatory lobes and ends with group of setae. Vibratory plate bears 15 unfeathered rays. Thoracic legs 3-jointed, ending in curved claws. Three pairs of thoracic legs similar in structure but varying in size.

Remarks: In the arrangement of radial pore canals, and marginal area *P. reticulatum* is similar to *Paijenborchellina* sp.? 1 and *Paijenborchellina* sp.? 2 and *P. caudatum.* It differs from the above species in (1) ovate to wedge shaped carapace, (2) surface of the carapace ornamented with reticulations and (3) pits arranged between reticulations.

This species name is based on the important character of systematic importance, namely carapace sculptured with reticulations.

Type-locality: Backwaters of Bimili, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the collections of Zoological Survey of India, Calcutta, India.

Occurrence: Backwaters of Bimili and Balacheruvu tidal stream, East coast of India.

Subfamily: CYTHEROPTERINAE Hanai, 1957

Genus: *Cytheropteron* Sars, 1865

Cytheropteron alatum Sars, 1866

(Pl. 1, Fig. C)

Carapace smooth, thinly calcified, usually fragmentary, never articulated. Ventral margin gently undulatory, dorsal margin strongly arched, terminating in a prominent mid-posterior caudal process, anterior extremity obliquely rounded; narrow duplicature forms a crescent shaped anterior vestibule. Valves ventrolaterally inflated in an alar expansion, anterior edge of ala, a blade like carina; posterior edge of ala features 9 to 11 small flattened denticles, ala terminated by a short blunt spine. A mid-dorsal, dorso-median sulcus typical. Hingement quite simple, not crenulate, muscle scars not seen.

Length 0.70-0.73 mm; height 0.39-0.41 mm.

Cytheropteron alatum has been reported previously from Scandinavia (Sars 1866, 1928; Elofson 1941) off the British Isles (Brady & Norman 1889), the north Atlantic (Tressler 1941) and the Mediterranean (Puri, Bonaduce & Gervasio 1969).

Occurrence: Backwaters of Bimili, East coast of India.

Distribution: World-wide.

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A NEW SPECIES OF *PARALLELAPTERA* (HYMENOPTERA: MYMARIDAE) AN EGG PARASITOID OF TINGIDAE, FROM SOUTHERN INDIA[1]

DAVID LIVINGSTONE AND MOHAMED YACOOB[2]

(*With two photos & seven text-figures*)

INTRODUCTION

The genus *Parallelaptera* was erected by Enock (1909) with the type species *Parallelaptera panis.* The diagnostic features of the genus were described as follows: antennae eleven segmented in males and eight segmented in females; tarsomers four, together much longer than the tibia; thorax longer than the sessile abdomen; wings without any surface hairs but with long parallel marginal cilia; hindwings almost as long as the forewing and ovipositor projecting far beyond the apex of the abdomen. Subsequently, Girault (1911) tentatively described yet another related species (*Anthemiella rex*) which was a year later confirmed by him (Girault 1912) as *Parallelaptera rex.* These are the only two recorded species of *Parallelaptera* so far known from literature.

The present description of a new species is based on specimens collected from the parasitized eggs of the *Ocimum* tingid, *Cochlochila bullita.* The only other species of mymarid parasitoid on tingid eggs was reported to be *Erythmelus empoascae,* reared from the eggs of the *Vitex* giant tingid *Ammianus ravanus* (Kirkaldy); the teak tingid, *Pontanus puerilis* Drake and Poor and the *Lantana* tingid, *Teleonemia scrupulosa* Stal (Livingstone *et al.* 1982 and Yacoob and Livingstone 1983). *E. empoascae* was described first by Subba Rao (1966) as egg parasite of jassids.

Parallelaptera polyphaga sp. nov.

(Photo. 1-2 & Figs. 1-7)

FEMALE: (Photo. 1) Minute; length entire 0.58 mm, width across the eggs 0.14 mm and across the thorax 0.14 mm; generally dark brown; body beneath and legs pale brown.

Head: triangular when viewed frontally; with long stiff bristles at the base of each antenna; a pair of long bristles at the posterior corner of each eye directing backwards and another pair outer to the ocelli; a pair of dorsal bristles

[1] Contribution No. 49. Accepted December 1985.

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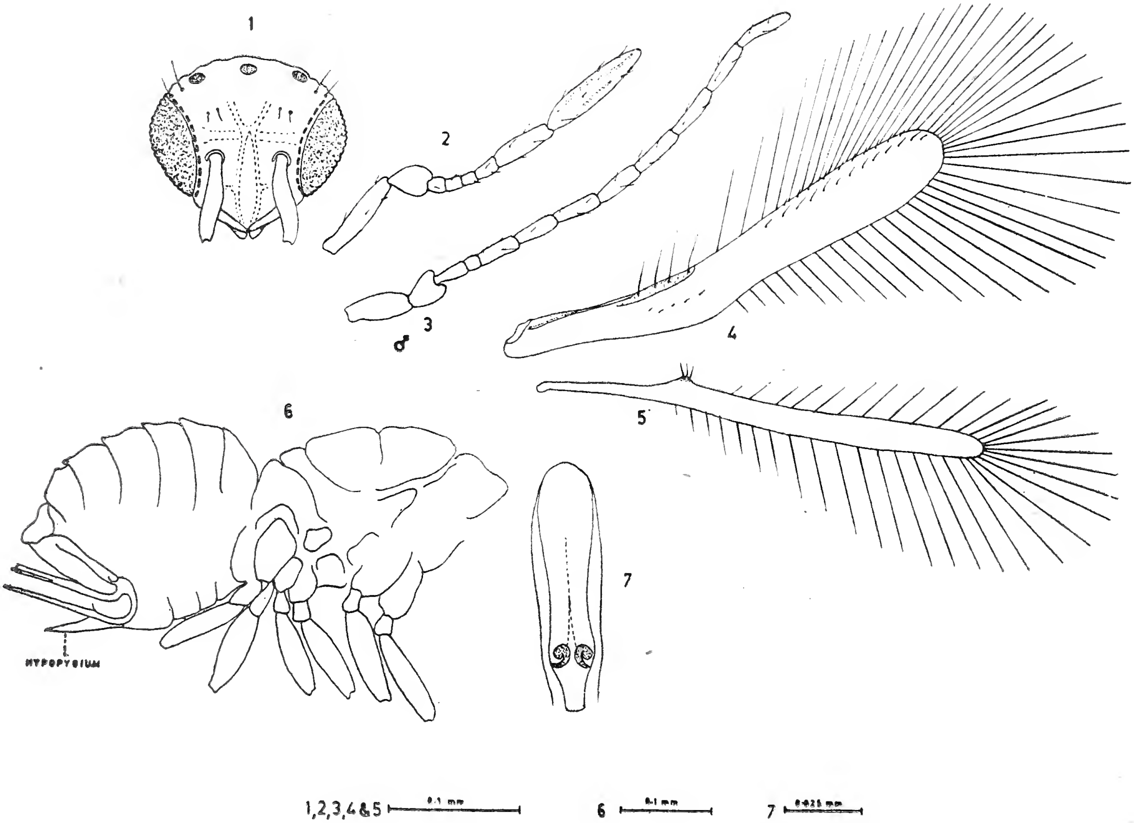
midway between eyes and another median bristle on the clypeus directing anteriorly; eyes sanguineous, widely separated; ocelli three, pale brown; antennae long, slender, inserted frontally; antennomeres with sparsely distributed minute stiff hairs; scape long with small stumpy radical, 5.23 times longer than its width; pedicel short, expanded, less than half the length of the scape; funicle five segmented, fifth segment expanded and almost as long as the first four segments combined — their lengths as follows — 1:1:0.77:1.3:3.6; club with three elongately expanded sensoria, 4.4 times longer than its greatest width, 1.3 times longer than the scape and 1.9 times longer than the fifth funicular segment; mandibles small, subtriangular tridentate.

Thorax: elongate, 1.5 times longer than its width, 1.75 times longer than the head and 1.2 times longer than the abdomen; pronotum subtriangular, broadly ovate anteriorly; 2 pairs of median long bristles present one behind the other; mesonotum broad and mesophragma very long, projecting upto the second abdominal segment; meso and metascutum and scutellum totally bare; forewings narrowly elongate, uniformly broad, apically rounded, almost equal to the body size, hyaline, basally infuscated upto the stigmal level; four long



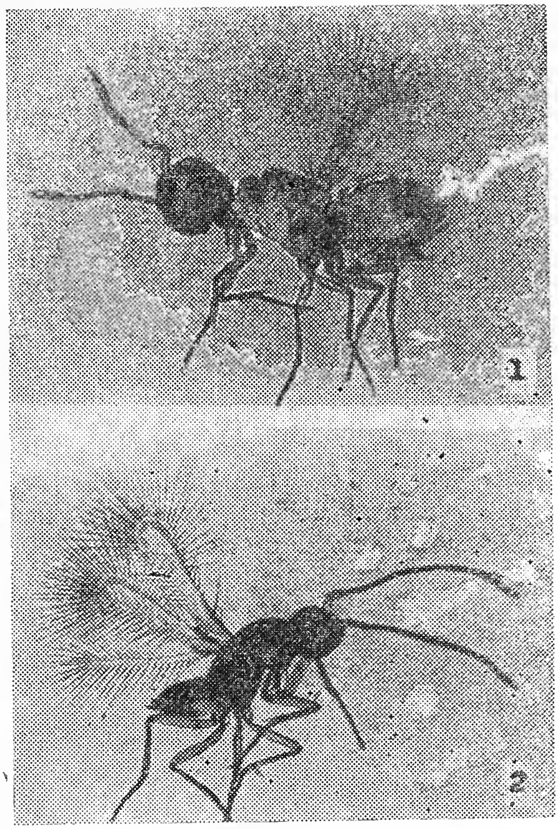
Figs. 1-7. *Paralleloptera polyphaga* sp. nov.
1. Head, front view; 2. Antenna — female; 3. Antenna — male; 4. Forewing; 5. Hind wing; 6. Lateral view of thorax and abdomen — female; 7. Male genital segment.

stiff bristles present over the stigma, one bristle more than double the length of the rest; remigium with a row of costal and sub-costal ciliation; cubitus with short cilia; the rest of the remigium bare; marginal fringes very long, gradually increasing in length from base to apex, reaching a maximum of 0.18 mm; stigmal vein short, straight, stumpy; hindwing uniformly narrow, elongate, almost as long as the forewing; marginal fringes gradually increasing in length towards the apex but slightly shorter when compared with the fringe of the forewings; legs long, slender; fore and hind coxae equal in length and twice as long as the middle one; fore and hind femorae slightly longer than the middle femora; foretibia slightly swollen apically with long combed tibial spur, extending almost upto the the middle of the first tarsomere; middle tibia more elongate, 1.2 times as long as the foretibia and 1.1 times as long as the hind tibia; tarsomeres equal in length, together as long as the tibia.

Abdomen: Sessile, truncate, longer than broad, 0.84 times as long as the thorax; a pair of bristles present dorsomedially on either side; 8th and 9th terga dorsally with tufts of slender hairs; ovipositor slightly extending beyond the apex of the abdomen and occupying 3/4th entire length of the abdomen; hypopygium, long, terminating subapically.

MALE: (Photo. 2) A little smaller than the female, antennae (dimorphic) with 10 funicular segments, second funicular segment not more than half the length of any of the rest of the segments; male genitalia 102 micra long and 0.6 times as long as the abdomen.

Parallelaptera polyphaga is so named because this is the only mymarid tingid egg parasitoid so far recorded that has the largest number of host species. About 22 species belonging to 16 genera of tingids recorded on about 30 species belonging to 16 families of host plants, are known to be attacked by this species (Yacoob and Livingstone 1983).



Photos. 1-2. *Parallelaptera polyphaga* sp. nov.
1. Female; 2. Male.

Parallelaptera polyphaga sp. nov. differs from *P. panis* and *P. rex* in its general coloration and in the morphology of the antennae and legs. It differs from *P. panis* in being light brown with sanguineous eyes and totally lack the golden yellow markings characteristically reported in *P. rex*.

The pedicel is short and more swollen than the scape in *P. polyphaga* whereas the scape in *P. panis* is reported to be slender. In type species, the second funicular segment is almost as long as the first and third segments combined. In the males however, the second funicular segment is almost half the length of the rest of the segments. The tarsomeres collectively do not exceed the length of the tibia. The tibial spur of the foretibia is comb like. Though the wings are generally regarded to be free from ciliation in the other two species described earlier, the costal and cubital cilia are significantly developed in this species. The ovipositor in the present species projects only a little beyond the abdomen and the hypopygium is prominently developed, reaching almost upto the tip of the abdomen.

Holotype: Female, reared from the egg of the tingid *Teleonemia scrupulosa* Stal, collected from Chamundi Hills, S. India on 8-1-1980.

Allotype: Male, also reared from the egg of the same species of tingid from the same locality.

Paratypes: the same data as the holotype.

Types mounted on slides and deposited for the present in the Division of Entomology, Bharathiar University, Coimbatore, S. India.

ACKNOWLEDGEMENTS

We are indebted to the Indian Council of Agricultural Research, New Delhi for financial support and the authorities of the University of Madras and Bharathiar University for facilities.

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DESCRIPTION OF TWO NEW SPECIES OF GENUS *ACROCERATITIS* HENDEL (DIPTERA: TEPHRITIDAE) FROM CHANDIGARH, INDIA[1]

PREMLATA & AWTAR SINGH[2]

(*With two text-figures*)

INTRODUCTION

The genus *Acroceratitis* (=*Stictaspis* Bezzi 1913) was first erected by Hendel 1913 for the type species *Acroceratitis plumosa.* This genus is characterised by the third antennal segment being pointed at the apex, long plumose arista and a swollen scutellum, the latter yellow with black markings or black with yellow markings. Presently the genus has 19 Oriental and 5

[1] Accepted March 1986.

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African species (Hardy 1973). Two new species are described in this paper.

Acroceratitis flava sp. nov.
Fig. 1 (A-D)

FEMALE:

Head: Oval, ratio of length, height and width: 3:4.6:6; frons pale with a brown marking above the lunule, almost as broad as long, 3 pairs of inferior and 2 pairs of superior fronto orbitals; inner verticals 3 times the outer verticals, post verticals and post ocellars small; ocellar triangle grey, ocelli yellow, ocellars as long as inner verticals; occiput fulvous, occipitals well developed and black; face white, proboscis pale with pale pubescence, palpi large and pale with black bristles; antennae yellow, 3rd segment fulvous and pointed at apex, arista long plumose; eyes black with red margin.

Thorax: mainly yellow, pubescent with three light brown vittae on the scutum and two black spots at the posterior corners of dorsum; scutellum yellow with three shining black spots, the median one large; dorsocentrals placed behind the anterior supra alars; pleurae yellow; thoracic chaetotaxy: scapulars 4, humeral 1, presutural 1, notopleurals 2, mesopleural 1, pteropleural 1, sternopleural 1, anterior supralar 1, posterior supra alars 2, dorsocentrals 2, prescutellars 2 and scutellars 4.

Legs: yellow with rows of black bristles on femorae.

Wings mainly hyaline with three fusco-fulvous bands, first two bands run parallel to each other across the entire length of the wing, the first one starts from stigma while second and third bands start from the middle of 2nd costal cell, third band goes upto the apex of R5 along costa; r-m cross vein at the middle of 2nd M_2.

Abdomen: fulvous with pale pubescence, third, fourth and fifth segment with 2 median black spots each.

Ovipositor tawny, measures 1.1 mm, oviscape large, equals the length of last three abdominal segments, piercer red and pointed.

Length of body (excluding the ovipositor) ♀; 4.8 mm; wing: 4.7 mm.

Material Examined: Holotype ♀, Panjab University, Chandigarh 10.xii.1984, coll. Premlata. Type deposited with the museum, Deptt. of Zoology, Panjab University, Chandigarh.

STATUS AND RELATIONSHIP

A. plumosa	*A. flava* sp. nov.
1. Two pairs of inferior fronto orbitals	Three pairs of inferior fronto orbitals.
2. Cross-vein r-m placed at basal 1/3 of Ist M_2	r-m placed at the middle of Ist M_2.
3. Mesonotal black spot present	Mesonotal black spot absent.
4. Abdominal spots transverse & long	Abdominal spots rounded.

From the above differences, it is evident that *Acroceratitis flava* is a new species.

Acroceratitis maculata sp. nov.
Fig. 2 (a - f)

MALE.

Head: pale and broad, ratio of length, height and width; 6:9:11; eyes oblong and dark brown; frons pale white but yellow towards antennae, 2 pairs each of superior and inferior

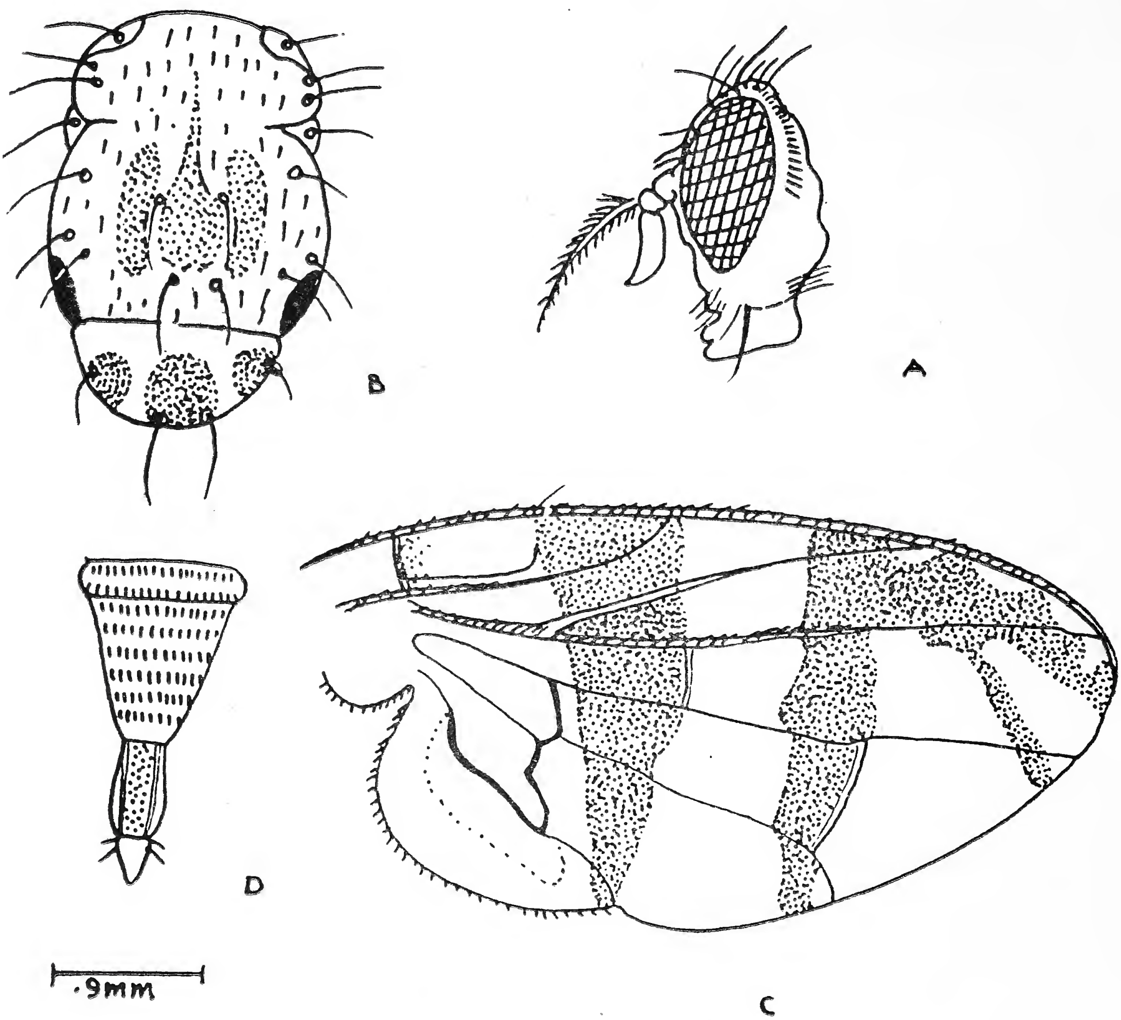

Fig. 1. (A-D): *Acroceratitis flava* sp. nov.
A. Head; B. Thorax; C. Wing; D. Ovipositor.

fronto orbitals; inner verticals 3 times the outer verticals, post ocellars and post verticals small; ocellar triangle brownish black, ocelli golden, ocellar as long as inner verticals; occipital setae 11, black and well developed; occiput pale and pubescent on lower side; lunule rufous; face pale and flat with a triangular median black spot; proboscis small, labial palpi thickly bristled; antennae situated with a spine like point at the apex, arista long plumose.

Thorax: yellow, humeral callus white with a black spot behind it, scutum with 5 shining black vittae, the broader median running to the entire length narrows anteriorly and with two black spots located postero laterally which further extends to the scutellum; scutellum entirely black with 2 very small apical and two basal yellow spots, dorsocentrals below in line

with the anterior supra-alars; pleurae yellow; thoracic chaetotaxy; scapulars 4, humeral 1, notopleurals 2, mesopleurals 2, pteropleural 1, sternopleural 1, presutural 1, dorsocentrals 2, prescutellars 2, anterior supra alar 1, posterior supra alars 2, and scutellars 4, all bristles black and well developed.

Legs: yellow, front femorae with five bristles posteriorly, midtibia with a prominent spur.

Wings: hyaline with all the three fuscous

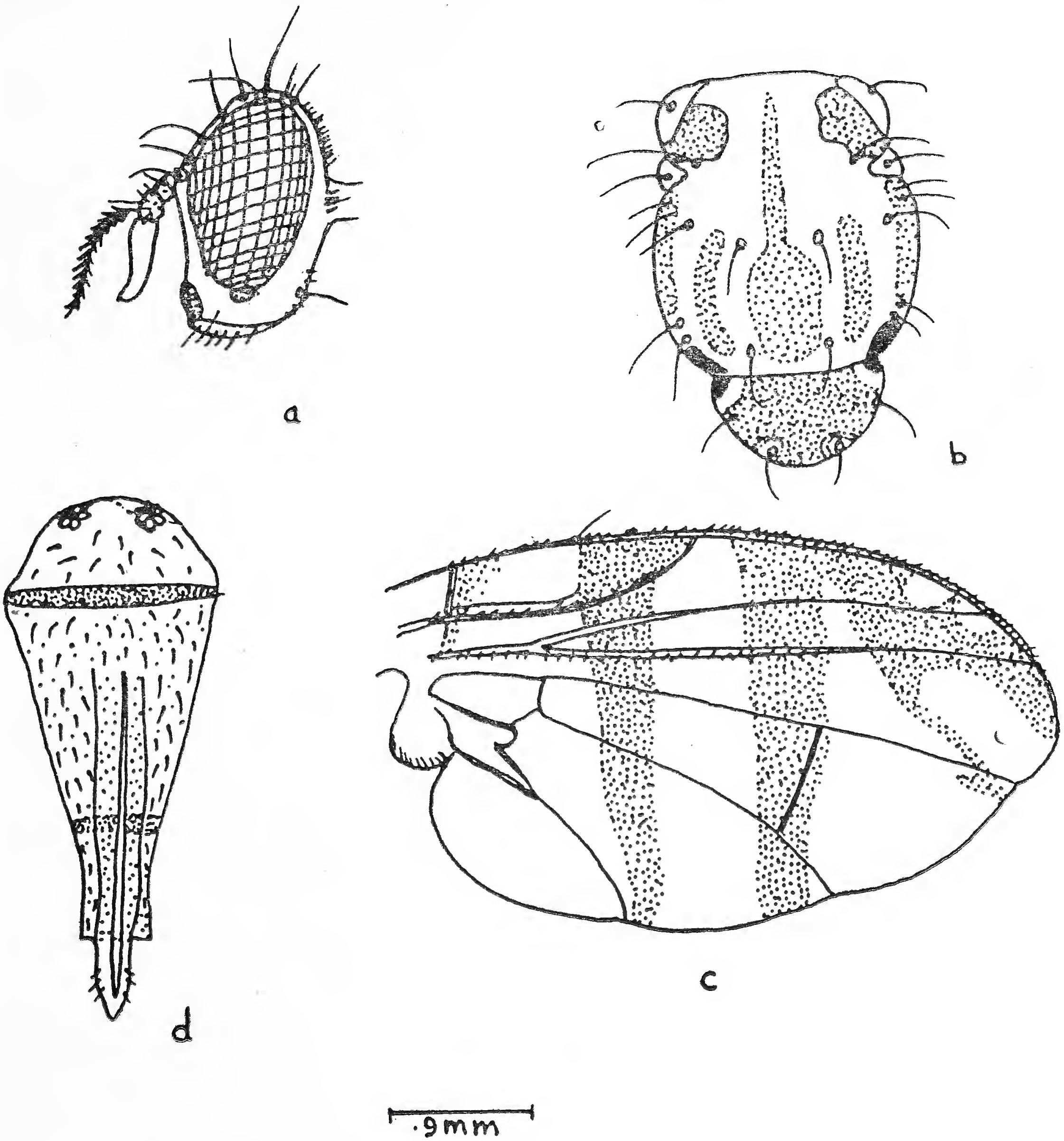

Fig. 2 (a-d): *Acroceratitis maculata* sp. nov.
a. Head; b. Thorax; c. Wing; d. Ovipositor.

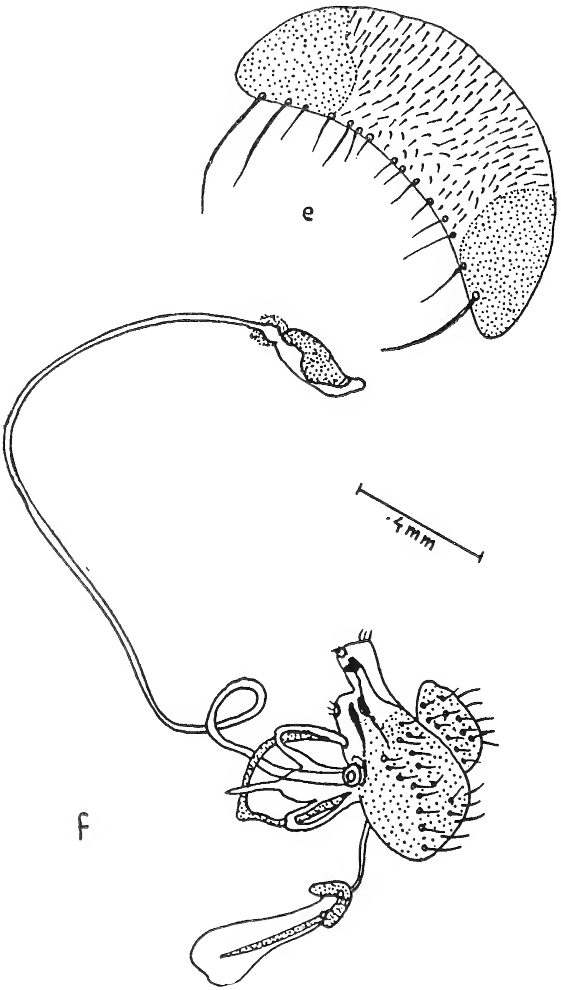

Fig. 2 (e-f): *Acroceratitis maculata* sp. nov.
e. 5th Sternum of male; f. Male Genitalia.

bands separate, the preapical oblique band becomes very faint before joining with costal band, the band across 'm' cross vein complete but does not join the costal band; r-m cross vein situated at basal 1/3 of cell Ist M_2 and cubital cell 2/3 as long as vein $Cu_2 + 1A$, vein R4 + 5 setose to a level almost opposite the tip of vein M_3+_4.

Abdomen: mainly brown, second segment yellow, third to sixth segment becoming lighter in colour and bordered with bristles posteriorly.

Male Genitalia yellow except the dark brown sclerotized aedeagus and 9th tergite; surstyli pointed at tip and ending in two lobes, the posterior one slightly bigger; fultella andiron type; ejaculatory apodeme small and fan narrow; outer claspers well developed with two equal prensisetae.

FEMALE

It resembles the male except in the following: Abdomn tapering posteriorly, sixth abdominal segment shorter than the fifth.

Ovipositor: Basal segment rufous but black caudally, equals last 4 abdominal segments, measures 2.6 mm, inversion membrane small and telescopic; piercer yellow pointed at tip.

Length of body ♂: 4.8 mm; wing: 4.6 mm.

Length of body (excluding the ovipositor) ♀: 4.7 mm; wing: 4.6 mm.

Material Examined: Holotype ♂ 31.x.1985; Bamboo shoots; Chandigarh, India: Coll. Premlata.

Status and Relationship

The species superficially resembles *A. tomentosa* Hardy but is distinct from it in the following characters:

A. tomentosa	*A. maculata* sp. nov.
1. Face without any spot.	Face with a triangular black spot.
2. Second and third bands of the wing joined at costal margin.	2nd and 3rd bands separate.
3. R_4+_5 setose for the entire length	R_4+_5 setose level with tip of vein M_3+_4.
4. Cuc cell lobe 1/3 of vein Cu_1+_{1st} A.	Cu cell lobe 2/3 of vein Cu_1+_{1st} A.
5. Piercer with 5 pairs of setae	Piercer with 3 pairs of setae.

The above differences are sufficient to establish *Acroceratitis maculata* as a new species.

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We thank Dr. H. S. Vasisht, Chairman, Department of Zoology, Panjab University, Chandigarh for the liberal facilities. They are also thankful to Prof. D. E. Hardy of Entomology Department, Honolulu, Hawaii for sending the literature. The first author is also thankful to CSIR for granting her a fellowship.

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ON A NEW SPECIES OF GENUS *STROPHOSOMOIDES* ASLAM FROM KASHMIR (TANYMECINAE, BRACHYDERINAE, CURCULIONIDAE, COLEOPTERA)[1]

H. R. PAJNI AND S. S. GANDHI[2]

(*With three text-figures*)

A new species *Strophosomoides pahalgamensis* is being described, raising the number of species under this genus to nine. A key to the known species is also provided.

INTRODUCTION

Out of 99 species of Indian Brachyderinae studied by us during a 5-year US. PL-480 project on Indian Curculionidae, as many as 28 species were found to be new. One such species belongs to genus *Strophosomoides* Aslam which is described in the present communication.

The genus *Strophosomoides* was raised by Aslam (1966) to include 8 species from Western Himalayas. Two of these species were collected from Kashmir valley. The present species has also been collected from Kashmir valley, but is quite different from all the 8 recorded species. As the type species for the genus has not been named by Aslam (1966), *S. gulmargensis* Aslam is being designated as type species of this genus. An enlarged key to the 9 world species under this genus is also being included. The characterization of genus *Strophosomoides* has been revised by including the structure of genitalia.

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Genus *Strophosomoides* Aslam

Aslam Ann. Mag. Nat. Hist., 1966, Ser. 13, Vol. IX, p. 129

Head with frons produced laterally over eyes and separated from vertex there. Eyes lateral and sulcate above. Rostrum narrowed from base to apex dorsally; scrobe deep, curved

either towards or away from eye; mandibular scar prominent. Antenna with scape variable; funicle with segment I slightly longer than 2, others moniliform. Prothorax transverse or as long as broad. Elytra without shoulders, gradually sloping or abruptly so near base. Legs with hind tibia not denticulate, corbels open; claws connate. Male genitalia with apex of aedeagus narrowly rounded; aedeagal apodemes longer than aedeagus; phallobasic apodeme shorter than aedeagal apodemes; endophallus with a sclerotized structure. Female genitalia with coxites longer than broad; styli longer than broad and beset with setae; spiculum ventrale thick and short, densely setose.

Type species: *Strophosomoides gulmargensis* Aslam.

Distribution: India: Pakistan.

KEY TO THE SPECIES OF GENUS *Strophosomoides* ASLAM

1. Upper margin of scrobe well defined and continued above eye. Frons and rostrum concave 2
— Upper margin of scrobe not well defined, interrupted by a raised area between scrobe and anterior margin of eye. Frons and rostrum not concave (except in *S. niger*) 3
2. Elytra roughly punctured and irregularly striate; third, fifth and seventh intervals more strongly raised than second, fourth and sixth; aedeagus long and curved .... *rugosus* Aslam
— Elytra uniformly punctured and regularly striate; dorsal intervals almost equally raised; aedeagus short and less strongly curved .... *gulmargensis* Aslam
3. Funicle with segment I not longer than 2 .... *pahalgamensis* sp. nov.
— Funicle with segment I longer than 2 4
4. Elytra impressed at base near suture, appearing keel shaped; frons and rostrum concave .... *niger* Aslam
— Elytra not impressed at base near suture; frons and rostrum almost flat 5
5. Mentum with more than two setae; second sternite of abdomen at sides as long as third and fourth together; antenna with scape not reaching posterior margin of eye 6
— Mentum with two setae; second sternite of abdomen at sides longer than third and fourth together; antenna with scape reaching posterior margin of eye 7
6. Aedeagus broad in middle, gradually narrowing to apex and base; elytra strongly humped and abruptly falling behind in female .... *championi* Aslam
— Aedeagus not broad at middle, gradually tapering from apex to base; elytra less humped and gradually falling behind in female .... *kumaonensis* Aslam
7. Elytra rounded at base and gradually sloping down to mesonotum .... *fastigatus* Aslam
— Elytra abruptly not rounded, vertical at base 8
8. Rostral furrow broad and not reaching vertex, pronotum finely granulate; body narrow .... *kaghanensis* Aslam
— Rostral furrow narrow and reaching vertex; pronotum coarsely granulate; body robust .... *kohistani* Aslam

Strophosomoides pahalgamensis sp. nov.

(Figs. 1-3)

Head with frons piceous, produced laterally over eyes and separated from vertex there, with a broad and shallow median furrow. Eyes black, almost circular and moderately prominent. Rostrum piceous, almost as long as broad, abruptly narrows down to apex; upper surface shallowly punctate, with a broad median furrow; scrobe deep and curved at a distance from eye; mandible scar conspicuous. Antennae with scape gradually clavate, exceeding middle of eye; funicle with joint 1 not longer than 2, 3-7 moniliform and subequal; club compact and ovate.

Prothorax much broader than long, strongly rounded laterally, broadest about middle, apex narrower than base; upper surface granulate dorsally and laterally, each granule with a seta, with a broad and shallow median furrow;

pattern formed by pale brown scales and setae. Scutellum indistinct.

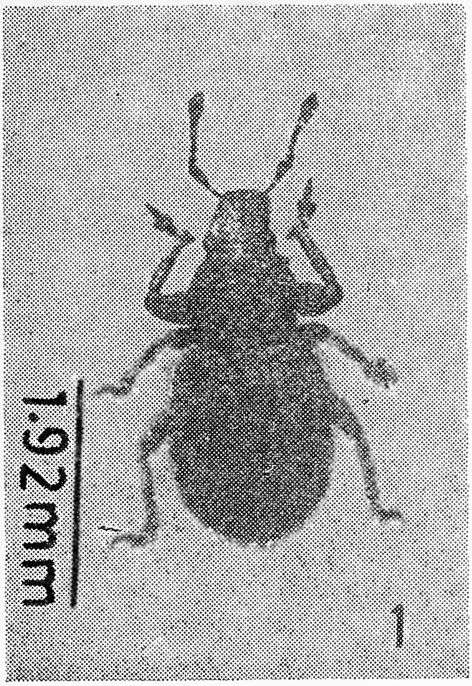

Fig. 1. *Strophosomoides pahalgamensis* sp. nov.: Adult.

Elytra piceous, subquadrate, shoulders not distinct, broadest about middle, base jointly and deeply sinuate and without margin, apices broadly rounded; surface convex, finely punctato-striate, intervals broad; pattern formed by pale brown scales, short and depressed setae in apical half, long and erect setae in basal half. Legs with tibiae finely serrate, corbels open; claws connate.

Abdomen with intercoxal process arcuate; visible sternite 2 almost equal to 3 and 4 together and separated from 1 by an angulated shallow furrow.

Male genitalia with aedeagus moderately sclerotized, with apex narrowly rounded; aedeagal apodemes longer than aedeagus; phal-

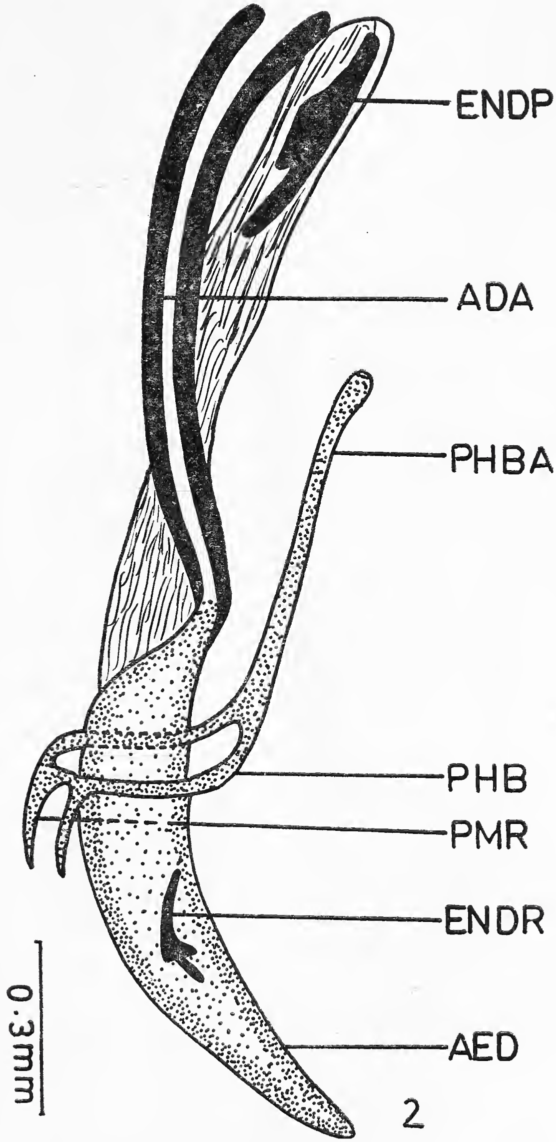

Fig. 2. *Strophosomoides pahalgamensis* sp. nov.: Male genitalia.

Abbreviations: ADA, Aedeagal apodeme; AED, Aedeagus; ENDP, Endophallic plate; ENDR, Endophallic rod; PHB, Phallobase; PHBA, Phallobasic apodeme; PMR, Paramere.

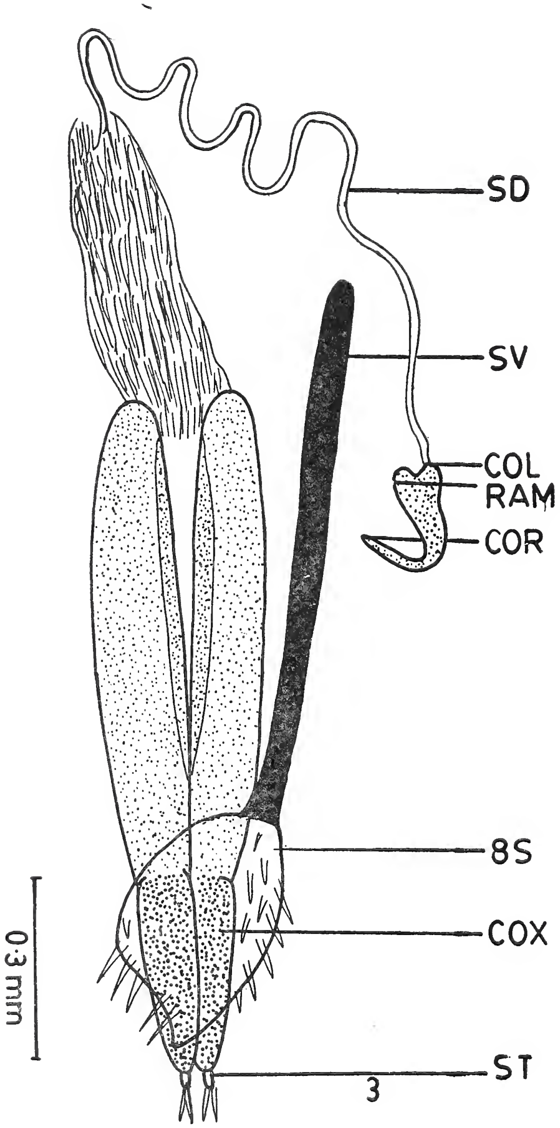

Fig. 3. *Strophosomoides pahalgamensis* sp. nov.: Female genitalia.

Abbreviations: COL, Collum; COR, Cornu; COX, Coxites; RAM, Ramus; SD, Spermathecal duct; ST, Stylus; 8S, 8th sternum; SV, Spiculum ventrale.

lotreme subapical; phallobasic apodeme shorter than aedeagal apodemes, parameres short; endophallus with transparent mass having short sclerotized rods. Female genitalia with coxites moderately sclerotized, much longer than broad (4.5:1) and sparsely setose; styli a little longer than broad and beset with 2 setae at apex; spiculum ventrale sclerotized and elongated, much dilated at base, densely setose; spermatheca with cornu narrowly pointed; ramus distinct at level with collum.

Measurements: Length of body: ♂, 2.8-3.0 mm.; ♀, 2.9-3.1 mm.; Width of body: ♂, 1.5-1.6 mm.; ♀, 1.4-1.6 mm.; Length of rostrum: ♂, 0.4-0.5 mm.; ♀, 0.4-0.5 mm.; Width of rostrum: ♂, 0.3-0.4 mm; ♀, 0.4-0.5 mm.

Holotype: MALE: Kashmir, Srinagar, Zabormon hill, Pari Mahal (understones), 25.5.1967, Dr. Topal. Paratype: 1 male, 1 female: Kashmir, Pahalgam (extracted grass clumps), 3.6.1967, Dr. G, Topal. (Types deposited in FRI, Dehradun).

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We are grateful to the ICAR and USDA for financing a 5 year project on Indian Curculionidae and for sanctioning funds for the trip of the first author to various European Museums for the study of type material. They are also thankful to Dr. Z. Kaszab of Hungarian Natural History Museum, Budapest, for the loan of material. The research facilities provided by the Chairman are also thankfully acknowledged.

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ISCHAEMUM AGASTYAMALAYANUM — A NEW SPECIES OF POACEAE FROM KERALA, INDIA[1]

P. V. Sreekumar, M. K. Janarthanam and A. N. Henry[2]

(*With a text-figure*)

Ischaemum agastyamalayanum sp. nov. (Fig. 1)

Ischaemum thomsonianum Stapf ex C.E.C. Fischer affinis sed spiculis sessilibus dense hirsutis, brevioribus, distincte 3-angulosis, sulcatis; racemis articulis non dentibus; glumis inferioribus spiculam sessilium ad apices trilobatis et non alatis; aristis glumarum superarum longioribus (*c.* 3 mm) et spiculis pedicellatis dense villosis differt.

Perennials. Culms 20-80 cm long, stoloniferous, trailing or geniculate, rarely erect; nodes bearded or glabrous. Leaves elliptic-lanceolate, lanceolate or linear-lanceolate, 3-20 × 0.5-1 cm, acuminate, rounded or shallowly cordate at base, covered with dense or sparse tubercle-based hairs. Sheaths keeled. Ligules ovate, acute, 2-4 mm long, membranous. Racemes 2, rarely 3, each 3-5 cm long, densely hairy; joints turbinate, 2-3 mm long, furrowed, densely hairy, hairs 0.5-3 mm long. Sessile spikelets oblong- lanceolate, 5-8 mm long (excl. arista), awned, densely villous; callus cuneate, densely bearded, hairs 1-2 mm long; lower glume broadly ovate-lanceolate, 5-6 × 2-3 mm, trilobed at apex (or very rarely bicuspidate, then the lobes divaricate), chartaceous, 11-13-nerved, densely hairy, hairs 1-3 mm long; upper glume boat-shaped or ovate-lanceolate when spread, 6-8 × 1-2 mm, acuminate with recurved tip shortly bifid and aristate, chartaceous, faintly 3-5-nerved, keeled on dorsal side, keel minutely winged and sparsely ciliate at the middle or towards apex, margins infolded, hyaline towards apex, arista 2-3 mm long; lower floret male; upper floret bisexual; first lemma ovate-oblong, 4.5-5 × 2 mm, acute, delicate, faintly 3-5-nerved, margins hyaline, ciliate towards apex; palea elliptic-lanceolate, 4-4.5 x 1 mm, chartaceous, 2-keeled, 2-nerved, margins infolded, delicate and hyaline; stamens 3, anthers 1-2 mm long; second lemma notched, 4-5 × 1.5-2 mm, delicate, hyaline, 3-nerved, awned, lobes acuminate, ciliolate towards apex; awn 12-15 mm long, column 5-6 mm long, brownish; palea oblong-lanceolate, 4-4.5 × 0.5-1 mm, delicate, hyaline, 2-nerved; stamens 3, anthers 2-3 mm long; ovary oblong, *c.* 0.5 mm, styles 1-1.5 mm long, stigmas *c.* 2 mm long. Pedicelled spikelets lanceolate or oblong-lanceolate, 4-7 mm long, awned, sometimes reduced; pedicels 2-2.5 mm long, densely villous; lower glume oblong-lanceolate or ovate-lanceolate, 5-6 × 1.5-2 mm, slightly bifid, acuminate, aristate, chartaceous, 9-11-nerved, keeled and densely villous on dorsal side; upper glume and florets similar to those of the sessile spikelets.

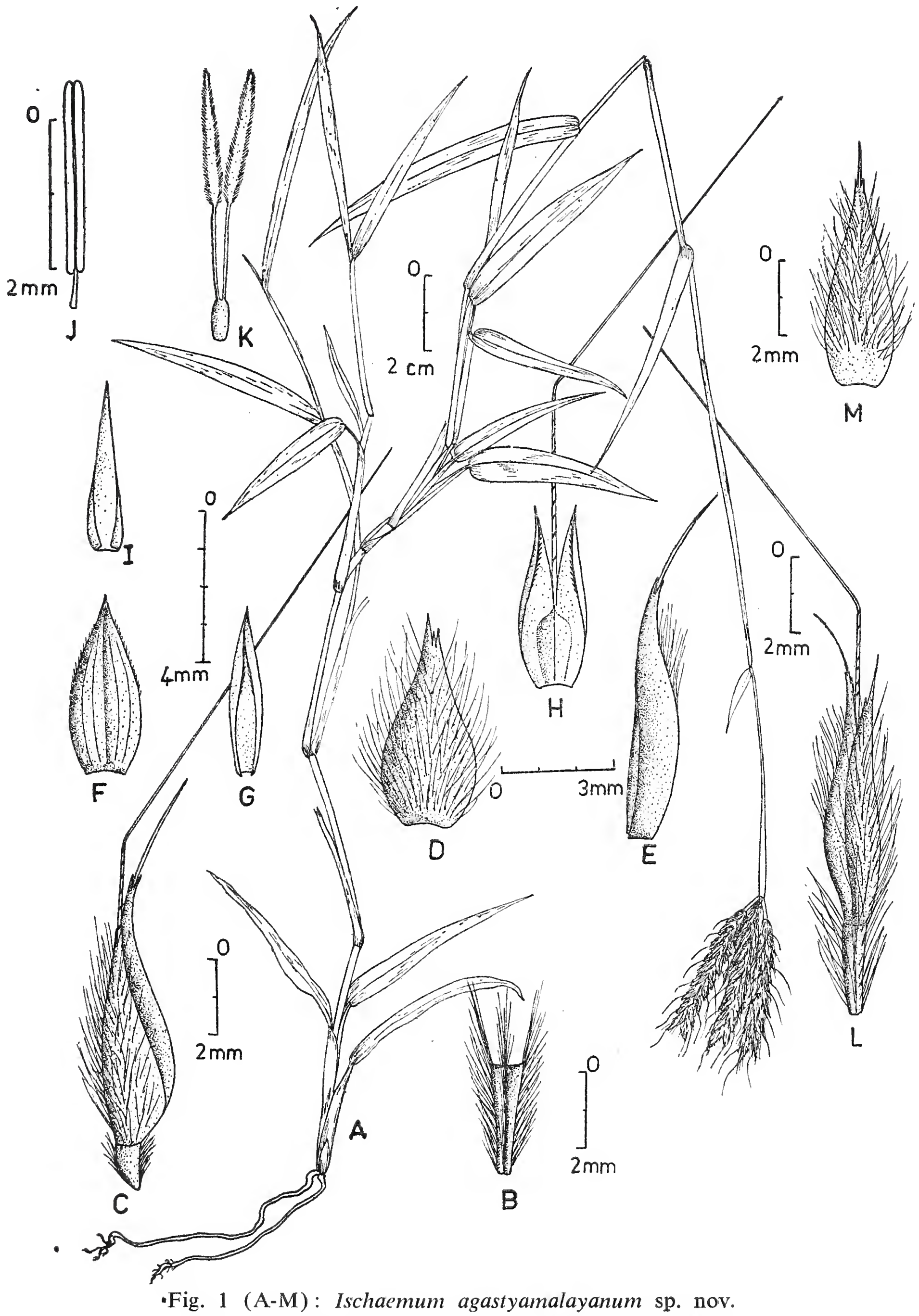
Holotype: INDIA. Kerala. Trivandrum Dt.: Western slopes of Agastyamalai, *c.* 1800 m, 6 October 1973, *J. Joseph* 44634 (CAL); *Isotypes* in MH (acc. nos. 86157, 86158 & 136876-136878); *Paratype*: Idukki Dt.: Lockhart gap, 13 December 1985, *M. K. Janarthanam* 82967 (MH Acc. No. 136889-136893).

Rare in the grassy hill slopes and in higher altitude grasslands.

Note: This species is allied to *Ischaemum thomsonianum*, but markedly differs from it as shown in the Table 1.

[1] Accepted October 1986.

[2] Botanical Survey of India, Southern Circle, TNAU Campus, Lawley Road P.O., Coimbatore 641 003. Tamil Nadu.



•Fig. 1 (A-M): *Ischaemum agastyamalayanum* sp. nov.
A. Habit; B. Joint of raceme; C. Sessile spikelet; D. Lower glume of Sessile spikelet; E. Upper glume; F. First lemma; G. Palea of the first lemma; H. Second Lemma; I. Palea of the Second lemma; J. Stamen; K. Pistil; L. Pedicelled spikelet; M. Lower glume of Pedicelled spikelet.

TABLE 1

	Ischaemum thomsonianum	*Ischaemum agastyamalayanum* sp. nov.
1.	Joints of racemes 3-4 mm long, densely ciliate along one angle, with a tooth-like projection on inner side	Joints 2-3 mm long, distinctly 3-angled, furrowed, densely villous all along, flat and without a tooth-like projection
2.	Lower glume of the sessile spikelets glabrous, bicuspidate, lobes straight, narrowly winged at apex	Lower glume densely hairy, trilobed at apex, if bicuspidate then the lobes divaricate, not winged at apex.
3.	Arista on the upper glume 1-2 mm long	Arista *c.* 3 mm long
4.	Pedicelled spikelets glabrous	Pedicelled spikelets densely villous

We thank Dr. T. A. Cope of the Royal Botanic Gardens, Kew, England, for his valuable opinion on the specimens; Dr. V. J. Nair, Botanical Survey of India, Coimbatore for the Latin diagnosis and Mrs. C. P. Malathi for the habit sketch.

A NEW SPECIES OF *MERREMIA* HALL. F. (CONVOLVULACEAE) FROM INDIA[1]

M. M. BHANDARI[2]

(*With a text-figure*)

Merremia rajasthanensis sp. nov. (Fig. 1)

Planta annua, glabra, caulis serpens vel volubilis, valde trialatus alis 1-1.5 mm latis; internodium 8-15 cm longum. Folia alterna; petiolus 3-12 cm longus, adaxialiter sulcatus; lamina pedata, fere ad basin divisa, quinqueloba lobis inferioris iterum divisis, 1-2 — lobis; lobi lanceolati, 2.5-9.0 × 0.5-2.3 cm, lobo medio maximo apice acuminato basi angustata et marginibus integris nonnihil undulatis, venis abaxialiter prominentibus. Pendunculi 1-4-flori, axillares, 1.5-4.0 cm longi, quadriangulati; pedicelli quinqueangulati sulcatique, 0.9-1.3 cm longi, sursum sensim dilatati et ad apicem *c.* 0.3 cm lati; bracteae lineares, *c.* 0.5 cm longae, basi valde glandulosae et cicatricibus instructae. Flores aparti usque 2 cm lati. Sepala quinque, subaequalia, *c.* 1.1 × 0.7 cm, oblongo-ovata, mucronata, membranacea. Corolla alba, infundibulariformis, usque 2 cm longa; tubus 1.2-1.5 cm longus; lobi quinque, 0.5-0.7 cm longi, ad apicem rotundati, regione media glabra. Stamina filamentis *c.* 1 cm longis fere ad medium adnatis parte adnata dilatata et glanduloso-pilosa, pollinis grana 3-zonicolpata, laevia. Ovarium super discum prominentem quinquelobum insidens; stigma bilobum, glabrum. Capsula *c.* 0.7 cm diam., bruneola, subgloboso-pyramidalis, ad apicem stylo persistenti instructa. Semina 3(-4), hebetato-atra, *c.* 0.5 × 0.4 cm, oblongo-ovoidea, trigona, laevia, glabra.

This species is closely allied to *Merremia quinquefolia* (Linn.) Hall. f., but is easily distinguished by its pedate leaves, winged and glabrous stem and glabrous seeds. However, it appears to be related to the African *M. palmata* Hall. f. and *M. verecunda* Rendle.

[1] Accepted February 1987.

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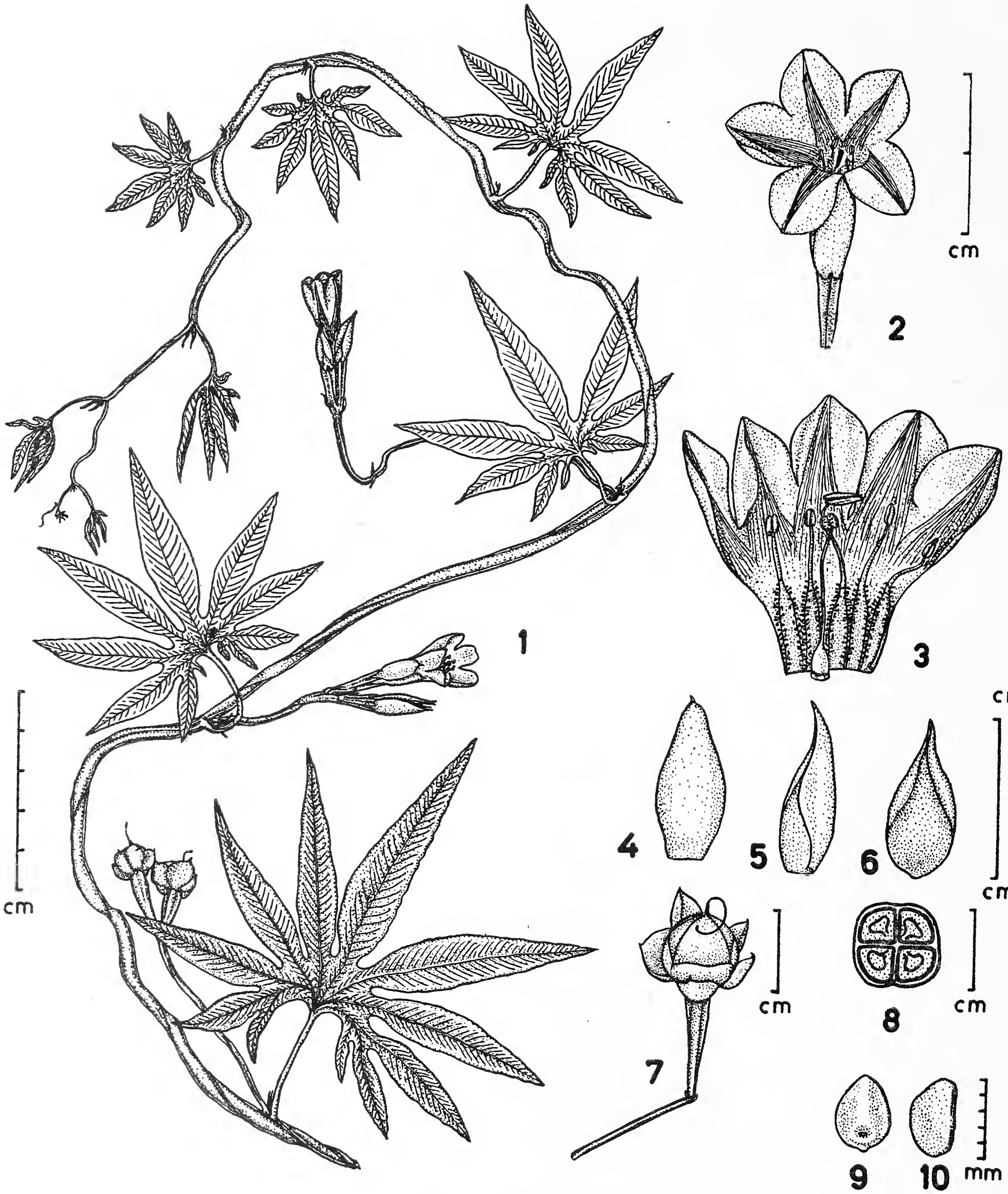

Fig. 1. *Merremia rajasthanensis* sp. nov.
1. Part of stem with inflorescence and fruits; 2. flower; 3. flower split open to show androecium and gynoecium; 4-6. sepals, dorsal, lateral and ventral view; 7. mature fruit with persistent calyx; 8. T.S. of fruit; 9-10. seeds, ventral and lateral view.

The stem of this species is typically winged like that of African *M. pterygocaulis* (Choisy) Hall. f.

Merremia rajasthanensis sp. nov. (Fig. 1)

Glabrous annual. Stem trailing or twining, conspicuously 3-winged, wings 1-1.5 mm wide; internodes 8-15 cm long. Leaves alternate; petiole 3-12 cm long, adaxially grooved; leaf-blade pedately divided nearly to the base, 5-lobed, the lower lobes again sub-divided into 1 or 2 lobes; lobes lanceolate, 2.5-9.0 × 0.5-2.3 cm, middle lobe the largest, apex acuminate, base narrowed, margins entire and very slightly undulate, veins abaxially prominent. Peduncles 1-4-flowered, axillary, 1.5-4.0 cm long, 4-angled; pedicels 5- angled and grooved, 0.9-1.3 cm long, gradually widening above, *c.* 0.3 cm wide at apex; bracts linear, *c.* 0.5 cm long, conspicuously glandular and scarred at the base. Flowers up to 2 cm across when fully open. Sepals 5, sub-equal, *c.* 1.1 × 0.7 cm, oblong-ovate, mucronate, membranous. Corolla white, funnel shaped, up to 2 cm long; tube 1.2-1.5 cm long; lobes 5, 0.5-0.7 cm long, rounded at apex, mid-petaline area glabrous. Staminal filaments *c.* 1 cm long, adnate nearly to the middle, the adnate portion dilated and glandular hairy on the sides, pollen 3-zonicolpate, smooth. Ovary based on 5-lobed prominent disk; stigma 2-lobed, globular. Capsule *c.* 0.7 cm in diam., light brown sub-globose-pyramidal, glabrous, surrounded by persistent, spreading calyx, apex with persistent style. Seeds 3 (–4), dull-black, *c.* 0.5 × 0.4 cm, oblong-ovoid, trigonous, smooth and glabrous.

RAJASTHAN DESERT: Jodhpur District: Sardarsamand, near margin of lake on field fences: *Bhandari*: 1976! date, 29.8.1975 (K, holotype; JAC, Isotype); Jodhpur University campus, twining on grasses: *Bhandari* 2185! date, 14.9.1975. BARMER DISTRICT: Climbing on shrubs and grasses on hillock behind Metaji's temple on rocks: *Bhandari* 2187! date, 8.9. 1976.

ACKNOWLEDGEMENT

I am grateful to Dr. Melanie Wilmot-Dear of Kew for Latin diagnosis.

ISACHNE HENRYI — A NEW SPECIES OF POACEAE FROM KERALA, INDIA[1]

S. R. SRINIVASAN AND P. V. SREEKUMAR[2]

(*With a text-figure*)

Isachne henryi sp. nov.
(Fig. 1)

Isachne miliacea Roth ex Roem. et Schult. affinis, sed foliis longioribus (usque ad 8 cm), lineario — lanceolatis; glumis 9-11-nervibus, setosis; antheris longioribus (1.5-2 mm) et pedicellis longioribus (usque ad 8 mm) differt.

Annual. Culms 15-50 cm long, creeping or geniculate, slender; nodes glabrous. Leaves lanceolate or linear-lanceolate, 2-8 × 0.2-0.5 cm, rounded or very shallowly cordate at base, scabrid along the nerves. Ligule a row of long hairs. Panicles 2-12 × 1-5 cm, widely spreading, green to purplish; peduncles long, exserted, branches 1-4 cm long, alternate. Spikelets broadly ovate or orbicular, 1.5-2 mm long,

[1] Accepted April 1987.
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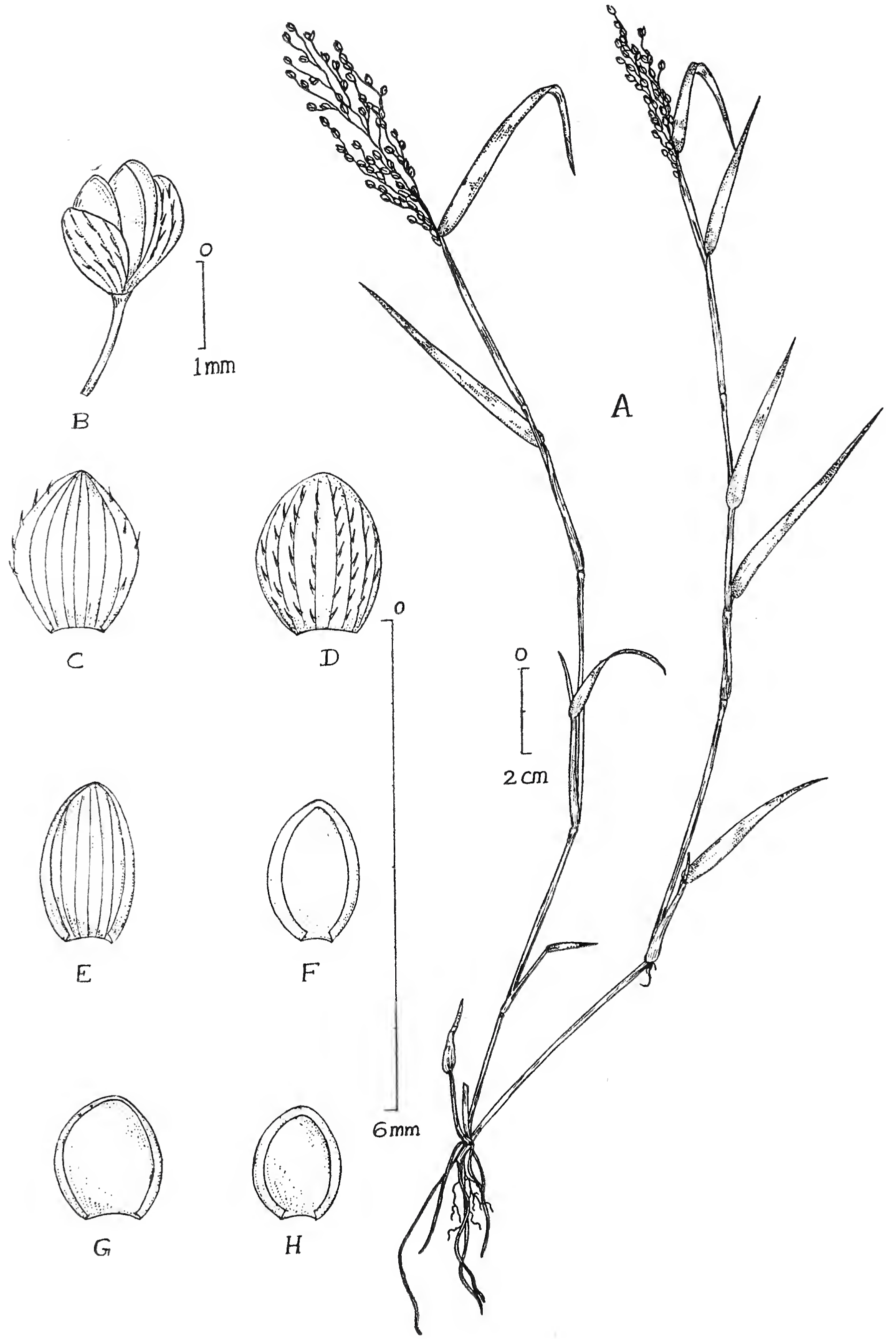

Fig. 1. (A-H): *Isachne henryi* sp. nov.
A. Habit; B. Spikelet; C. Lower glume (Ventral view); D. Upper glume (Dorsal view); E. First lemma; F. Palea of the first lemma; G. Second lemma; H. Palea of the second lemma.

sparsely hairy or glabrous, green to purplish; pedicels 1-8 mm long, slender, wavy, dilated at apex; glumes broadly ovate or orbicular, subequal, $1.75\text{-}2 \times 1.5\text{-}2$ mm, chartaceous, 9-11-nerved, setose hairy. Lower floret male: lemma broadly elliptic or ovate, $1.75\text{-}2 \times 1\text{-}1.25$ mm, obtuse, chartaceous, faintly 5-7-nerved, glabrous, margins inturned, hyaline; palea broadly ovate, $1.5\text{-}1.75 \times 1\text{-}1.25$ mm, obtuse, delicate, glabrous, margins 2-keeled, hyaline; stamens 3, anthers 1.5-2 mm long, filaments short. Upper floret bisexual: lemma orbicular, $1.25\text{-}1.5 \times 1.25\text{-}1.5$ mm, obtuse, coriaceous, faintly 5-7-nerved, glabrous; palea orbicular, $1\text{-}1.5 \times 1\text{-}1.25$ mm, obtuse, coriaceous, 2-keeled, glabrous, margins inturned, hyaline; stamens 3, anthers 0.75-1 mm long, filaments short; ovary oblong, 0.1-0.25 mm long, styles *c.* 0.25 mm long, stigmas feathery, 0.25-0.5 mm long.

Holotype: KERALA. Wynad District: Poothumoola, Hiladale R. F., ± 700 m, 13th November, 1981, *S. R. Srinivasan* 72358 (CAL). *Isotypes* in K, & MH (acc. Nos. 138695, 138696, 138697 & 138698).

Occasionally grows along the bunds of paddy fields.

This species is allied to *Isachne miliacea* Roth ex Roem. & Schult., but markedly differs from it as shown in the table.

TABLE

Isachne miliacea	*Isachne henryi* sp. nov.
1. Leaves ovate-lanceolate, up to 3 cm long	Leaves linear-lanceolate or lanceolate, up to 8 cm long
2. Glumes 5-7-nerved, glabrous	Glumes 9-11-nerved, setose-hairy
3. Anthers of the lower floret 0.5-1 mm long	Anthers of the lower floret 1.5-2 mm long
4. Pedicels up to 3 mm long	Pedicels up to 8 mm long.

The specific epithet is after Dr. A. N. Henry, Scientist D, Botanical Survey of India, Coimbatore in recognition of his significant contributions to the taxonomy and nomenclature of Indian plants.

ACKNOWLEDGEMENTS

We thank Dr. T. A. Cope of the Royal Botanic Gardens, Kew, England for his valuable opinion on the specimens, Dr. N. P. Balakrishnan, Scientist D, Botanical Survey of India for encouragement, Dr. V. J. Nair for the latin diagnosis and Smt. C. P. Malathi for the habit sketch.

A NEW SPECIES OF *NOTOTHYLAS* SULL. (BRYOPHYTA) FROM NEPAL[1]

D. K. SINGH[2]

(*With twenty eight text-figures*)

The genus *Notothylas* Sull., in the present state of our knowledge, is represented in the world by 17 species. Interestingly, the South-East Asian countries and Japan together account for the distribution of 14 species. Off these 12 species are confined to this region only whereas two species *Notothylas breutelii* (Got.) Got. and *N. dissecta* St. exhibit discontinuous distribution between South-East

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[2] Botanical Survey of India, Eastern Circle, Shillong-793 003.

Asia on one hand and the American land-mass on the other (Singh 1979, Udar & Singh 1979). Recently, during the course of a monographic study on Indian Notothylaceae some interesting specimens, belonging to the non-columellate section of the genus, represented in the collections of British Museum expedition to Central Nepal during 1949 and 1952 and partly deposited in the hepatic herbarium of the Lucknow University (LWU), were studied. A critical morpho-taxonomic investigation showed that they were distinct from hitherto known species of the genus. Hence, it is described in the present communication as *Notothylas nepalensis* sp. nov. The only other species of the genus, recorded from Nepal so far, is *N. levieri* Schiffn. (Hattori 1966, Singh 1979, in press).

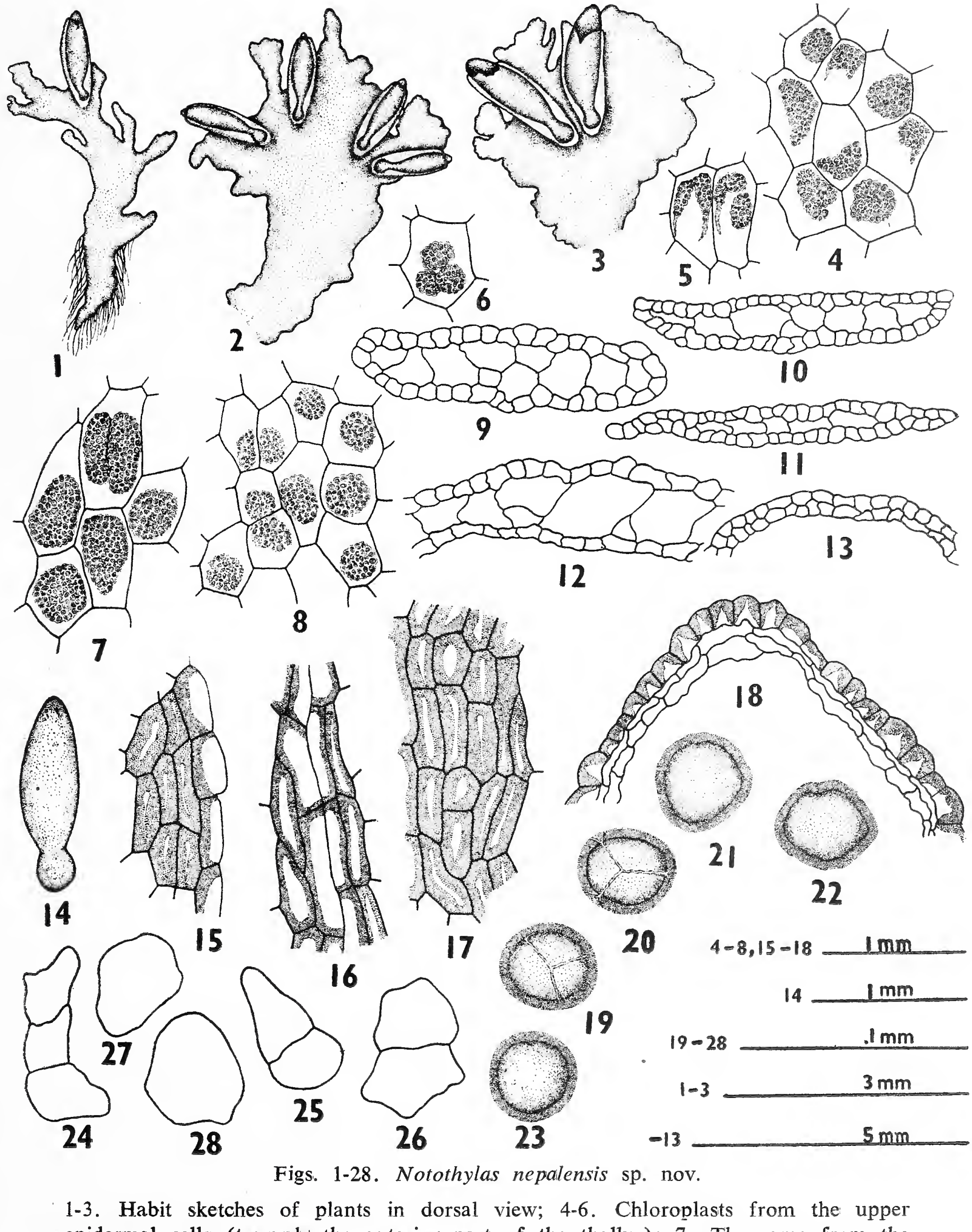
Notothylas nepalensis sp. nov.
(Figs. 1-28)

Plantae dioeciae; thalli prostrati parvi, tenelli, 2-4 cellulis crassi, cellulis strati mediani majoribus; plantae feminiae 2-4.5 mm longae, 0.7-3.5 mm lati; involucra submarginalia, ultra marginem thalli protrudentia; capsula cylindrica, involucrum leviter superans, longitudinaliter secus suturum dehiscens, cellulis specialibus secus marginem valvae in serie una dispositis, pariete capsulae nonstomatifera, tristratosa; columella carens; sporae flavo-brunneae, ovali-sphericae, 32.4-46 μm, superficie glabra, signo triradiato distincte notata.

Typus positus in Herbario Hepatico, sectionis botanices, Univ. Lucknow, Lucknow, India. Numero 3125 pro parte (Ex Herbaria Musei Britannici). *Notothylas nepalensis* sp. nov., *Anthoceros stephanii* Khanna consociata, Garhigaon prope Jumla (alt. 2879 m). leg. O. Polunin, W. R. Sykes et J.H.J. Williams, September 1952. det. D. K. Singh.

Plants prostrate, delicate, dichotomously branched, usually not forming rosettes, caespitose, linear — obcordate, small 2-4.5 mm long, 0.7-3.5 mm broad, lobes ecostate, broad, dorsal surface smooth, thalli compact, 3-4 cell layers thick in the middle, 1-3 cells thick at the margins; dorsal epidermal cells nonprotuberant, subquadrate — rectangulate, (24.3) 40.5-67.5 × (21.6) 29.7-46 μm towards apex, with 1(2-3) discoid to more or less 'U' shaped chloroplasts free from the inner cell walls, stroma reticuloid, pyrenoid region lacking; cells from the middle region of the thallus elongated rectangulate, 45-97.5 × 32-51.5 μm, with 1(2) discoid — ellipsoid chloroplasts free from inner cell walls; cells from the posterior part of the thallus rectangulate, (32-) 64.5-97.5 × 27-59.5 μm, with single chloroplast free from the inner cell walls; cells of the hypodermal layer much larger, often filled with mucilage, usually devoid of chloroplasts; cells from the lower epidermis subquadrate — rectangulate, (40.5) 54-81 × 32-50 μm towards apex with 1-3 discoid chloroplasts similar to those in dorsal epidermis, cells from the middle region of the thallus rectangulate, 43-86.5 × 18.5-43.5 μm with 1(–2) large, discoid — ellipsoid chloroplasts, cells from the posterior region of the thallus highly elongated, 64.5-110.5 × (24–) 29.5-43.5 μm, with single discoid to elongated chloroplast. *Nostoc* colonies not observed.

Rhizoids smooth walled, ventral scales and tubers lacking. Dioecious (?) male plants not seen. Involucres horizontally deflexed, submarginal, single or geminate, situated at the sinuses between the two lobes, usually not concealed by the latter, anterior part projecting well beyond the thallus margins, uniformly 2-cell layers thick towards base, 1-cell thick towards apex, surface smooth; sporogonia emergent, one in each involucre, 0.75-1.5 mm long, differentiated into a large bulbous foot, a subconspicuous meristematic zone and more or less ellipsoidal, yellowish brown capsule with



Figs. 1-28. *Notothylas nepalensis* sp. nov.

1-3. Habit sketches of plants in dorsal view; 4-6. Chloroplasts from the upper epidermal cells (towards the anterior part of the thallus); 7. The same from the middle region of the thallus; 8. Chloroplasts from the lower epidermal cells; 9-12. Cross-section of the thallus; 13. Cross-section of the involucre; 14. A complete sporogonium; 15-17. Epidermal cells of the capsule wall (figure 16 showing special cells bordering the line of dehiscence); 18. Cross-section of the capsule wall; 19-20. Spores in proximal view; 21-23. Spores in the distal view. 24-28. Pseudoelaters.

obtuse apex; capsule dehiscing longitudinally from apex downwards, sutures 2-4(–5), cells thick, capsule wall nonstomatiferous, 3-4 cell layers thick, cells of the epidermal layer yellowish brown, subquadrate — rectangulate, 24-40.5 × 27-35.5 μm towards apex rectangulate, 32-94.5 (–121.5) × 16-27 μm towards posterior part, with sheet-like thickenings present on transverse and radial walls, radial wall thickenings extending over outer tangential walls also, special cells bordering the margin of each valve in 1-2(3) rows, 18.5-32.5 × 18-35.5 μm at apex, (27-40.5) 48.5-121.5 × 8-27 μm towards base, thick walled, deeply pigmented, cells of the inner layers thin walled, hyaline, devoid of any thickening; columella absent, spores tetrahedral (32-50 μm in diameter) — oval (40.5-50 × 36.5-40.5 μm), yellowish brown, with a conspicuous equatorial crassitudo devoid of flange, exine surface obscure, proximal surface with conspicuous tortuous triradiate mark often continuous with equatorial girdle; pseudoelaters scarcely present, 1-3 celled, 45-69.5 × 16.5-47 μm in size, hyaline, devoid of thickening bands.

Type specimen represents the part of collections of British Museum Expedition to Central Nepal. The duplicate deposited in the Hepatic herbarium, Department of Botany, University of Lucknow, Lucknow (LWU) No. 3125. *Notothylas nepalensis* sp. nov. growing in fallowed field with *Anthoceros stephanii* Khanna. Loc. Garhigaon, S.E. of Jumla (alt. 2879 m). leg. O. polunin, W. R. Sykes and J.H.J. Williams, September 1952. det. D. K. Singh.

Other specimen examined: No. 173. Ex Herbario Musei Britannici. British Museum Expedition to Central Nepal, 1949. The duplicate deposited in the Hepatic herbarium, Department of Botany, University of Lucknow, Lucknow (LWU). *Notothylas nepalensis* sp. nov. grows on walls in association with sterile, tuber bearing, plants of *Phaeoceros himalayensis* (Kash.) Prosk. Loc. Langtang village area (alt. *c.* 3030 m). leg. O. Polunin, August 1949. det. D. K. Singh.

Characteristics of the species: 1. Plants dioecious; 2. Chloroplast stroma reticuloid, pyrenoid region lacking; 3. Involucres projecting well beyond the thallus margin, surface smooth; 4. Columella absent; 5. Yellowish brown spores with obscure exine surface and devoid of flange; 6. Pseudoelaters scarce, devoid of thickening bands.

Notothylas nepalensis, occurring at an altitude of *c.* 2879-3030 m, is a truly temperate species and is interesting in its vegetative as well as sporophytic features. In a fairly large number of specimens, from both the localities, a tendency to form rosettes is lacking. The plants are delicate and quite distinctive as the thallus is usually only 3-cell layers thick with the middle layer comprising of enormously large cells (Figs. 9-12) usually filled with mucilage. It is also remarkable in its chloroplast structure which apparently consists of numerous, discoid starch bodies (Figs. 4-8) separated from each other by hyaline streak — presumably 'thylakoids'. Interestingly, in this feature, the present species not only resembles *N. anaporata* Udar & Singh, a columellate species of the genus, but also shows a close analogy with *Megaceros tjibodensis* Campb. (Burr 1970, Kaja 1954, Udar & Singh 1981). Furthermore, while it shows resemblance with the genus *Megaceros* Campb. as well as certain species of the genus *Folioceros* Bharad., in the absence of a central pyrenoid complex from the chloroplast, it differs widely from its allied species (belonging to the noncolumellate section of the genus *Notothylas*) in this feature (Singh 1979, in press; Udar & Singh 1981).

N. nepalensis, in the complete absence of a columella, differs not only from all the persistently columellate species of the genus (e.g.

N. anaporata, N. dissecta, N. galapagensis Howe, *N. himalayensis* Udar & Singh, *N. indica* Kash., *N. pandei* Udar & Chandra) but also from such species as *N. breutelii, N. depressispora* J. Hasegawa, *N. javanica* (Sande Lac.) Gott., *N. orbicularis* (Schw.) Sull., *N. temperata* J. Hasegawa) which may or may not have columella in their fully matured capsules (see Hasegawa 1979, Singh 1979, Udar & Singh 1981). Amongst its own group, while the present species does not approach directly to any of the taxa, it differs considerably from them in most of the significant morphological details (e.g. thallus anatomy, chloroplast structure, sexuality, features of involucres, capsule wall structure, spore morphology and the sporoderm pattern, and the pseudoelater characteristics) having a direct bearing on the taxonomy of the genus (Singh 1979, Udar & Singh 1981).

Acknowledgements

I am greatly indebted to late Prof. Ram Udar, Department of Botany, University of Lucknow, Lucknow, for facilitating the study of the specimens of the British Museum of Natural History from Nepal, deposited at LWU and also for his valuable suggestions, and to Dr Edith K. Cash, Binghamton, New York, for Latin rendering of the diagnosis. I am also grateful to the Director, Botanical Survey of India, Calcutta, for encouragement and facilities.

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A NEW SPECIES OF WHITEFLY *MIXALEYRODES INDICUS* SP. NOV. (ALEYRODIDAE: HOMOPTERA) FROM INDIA[1]

B. V. DAVID[2] AND S. SELVAKUMARAN[3]

(*With three text-figures*)

Takahashi (1936) erected the genus *Mixaleyrodes*, the type-species being *Mixaleyrodes polystichi* from Taiwan. In 1963 he added one more species namely *M. polypodicola* from Japan

A species of aleyrodid collected from *Litsea travancorica* (Lauraceae) at Idukki, Kerala State during June 1986 by one of the authors (S.S.) has been found to be new and very close to the genus *Mixaleyrodes.* This species does not readily fit into the generic characters of *Mixaleyrodes* due to absence of thoracic and tracheal pores or clefts and folds. However, at present it is assigned to the genus *Mixaleyrodes* Takahashi and as it is distinct from the two known species it is described here as a new species.

Mixaleyrodes indicus sp. nov.
(Figs. 1-3)

Pupal case: Small, elliptic, translucent yellow with wax secretion; 0.50-0.58 mm long, 0.29-0.36 mm wide; found singly on the undersurface of leaf.

Margin: Crenate with 26-29 rounded teeth in 0.1 mm; folded inwards and gives appearance of a submargin; thoracic and caudal pores or clefts absent. Anterior and posterior marginal setae present, 0.02 mm long.

[1] Accepted May 1987.

[2] *Present address*: Rhone-Poulenc Agrochemicals (India) Limited, May Baker House, Worli, Bombay-400 025.

[3] Fredrick Institute of Plant Protection and Toxicology, Padappai 601 301, India.

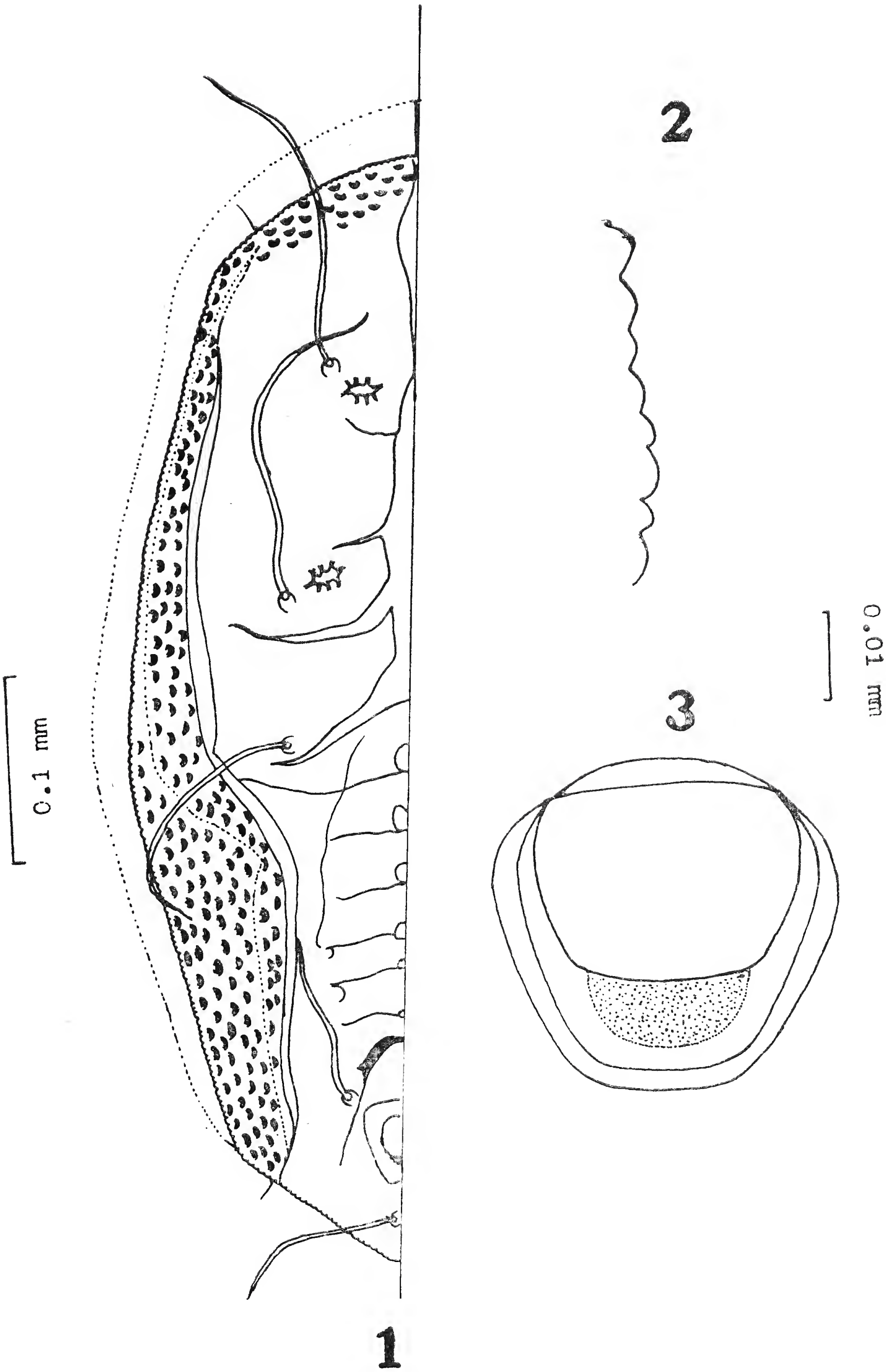
Dorsal surface: Dorsal disc separated from subdorsum by a distinct lateral longitudinal fold. Five pairs of dorsal setae arising on tubercles evident: a pair of cephalic setae 0.12-0.17 mm long, a pair on each of meso- and metathoracic segments 0.11-0.15 mm long, a pair on eighth abdominal segment laterad of vasiform orifice 0.07-0.09 mm long, and a pair of caudal setae arising on submarginal tubercle 0.08-0.10 mm long; setae on prothorax and first abdominal segment absent. Longitudinal moulting suture extends to margin, transverse moulting suture short. A distinct pocket evident at base of cephalic and mesothoracic setae. First six abdominal segments with a distinct tubercle on each. Subdorsum with uniformly distributed tuberculate markings. Seventh abdominal segment shorter than sixth and eighth.

Vasiform orifice: Elevated, roundly cordate with thick lateral walls, measures 0.040-0.045 mm × 0.040-0.042 mm; operculum 0.025 × 0.022 mm. rounded; lingula tip exposed and setose.

Ventral surface: Ventral abdominal setae not discernible; anterior and posterior abdominal spiracles evident; antenna short and does not extend beyond base of foreleg.

Material examined: *Holotype. Litsea travancorica,* Idukki (Kerala State), 13.6.1986, Coll. S. Selvakumaran.

Paratypes: 7 pupal cases on slides bearing same data as of holotype: 3 have been retain-



Figs. 1-3. *Mixaleyrodes indicus* sp. nov.
1. Pupal case; 2. Margin; 3. Vasiform orifice.

ed in the collections of B.V. David and the rest deposited in the collections of the Zoological Survey of India, Calcutta, Division of Entomology, IARI, New Delhi, Systematic Entomology Laboratory, USDA, Washington, and the British Museum (Natural History), London.

ACKNOWLEDGEMENT

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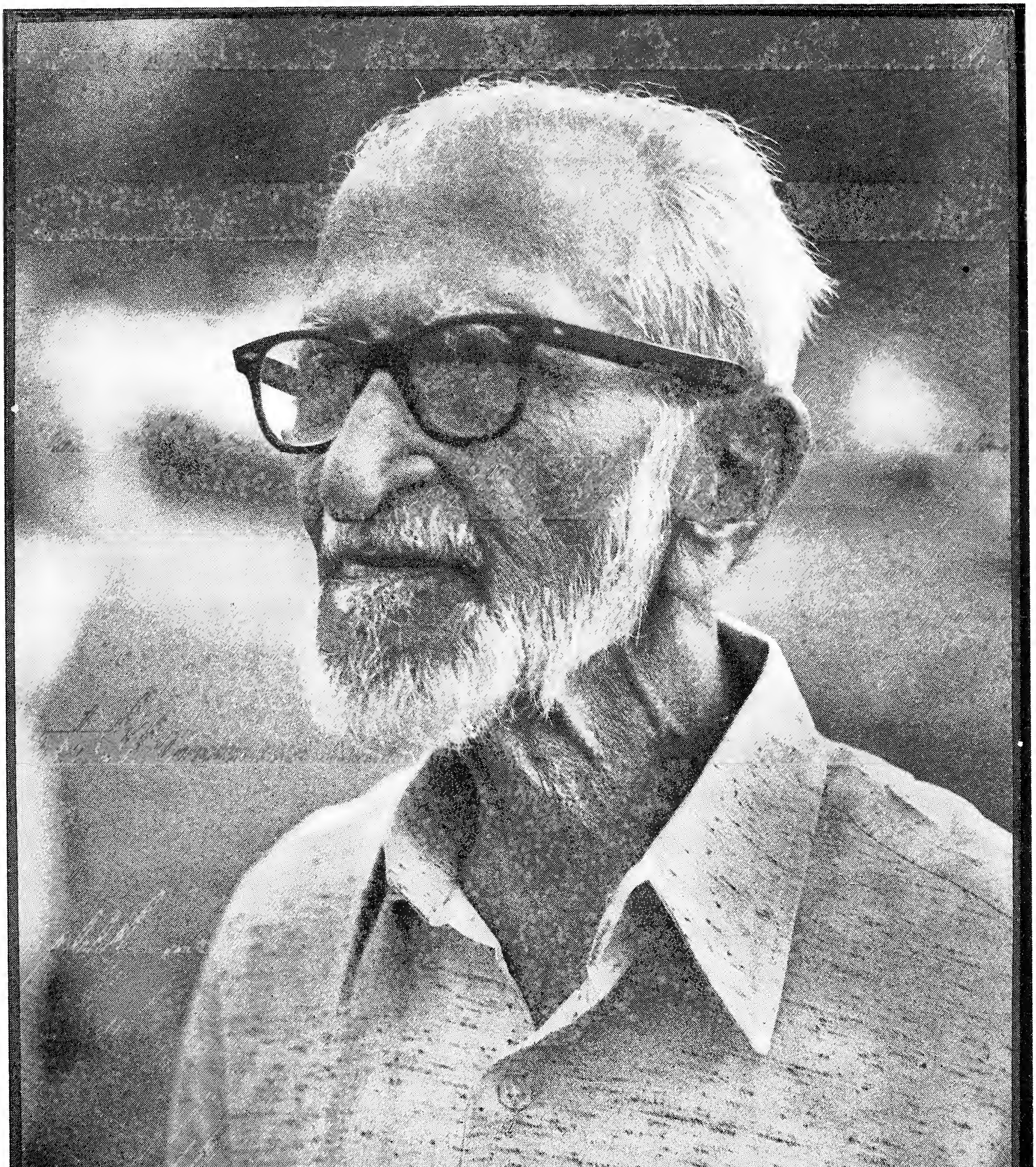

Sálim Ali
(1896-1987)
(*Photo*: G.C. Patel)

OBITUARIES

SALIM ALI
(1896-1987)

(*With a plate*)

Sálim Ali says that I gave him the idea of writing his life-story, which he entitled enigmatically THE FALL OF A SPARROW, and gave me a copy with an affectionate inscription. It is therefore after much hesitation that I agree to the Editors' invitation to attempt an assessment for this *Journal.*

I am encouraged by the second Appendix in Sálim's own book entitled 'To See Ourselves As Others See Us' which reproduces very unflattering passages from Richard Meinertzhagen's diaries: "I am disappointed in Sálim" — this was written in 1937, at the beginning of an expedition to Afghanistan — "He is quite useless at anything but collecting. He cannot skin a bird, nor cook, nor do anything connected with camp life, packing up or chopping wood. He writes interminable notes about something — perhaps me . . .' Even collecting he never does on his own initiative. Like all Indians he is incredibly incompetent at anything he does; if there is a wrong way of doing things he will do it, and he is quite incapable of thinking ahead." Later Meinertzhagen and Sálim, both stubborn men, became close friends, and Sálim was one of the few intimates given access to the Diaries.

Sálim's own autobiography was published in 1985. It was widely read and appreciated in India, and the *Ibis* notice in January 1987 begins: 'For almost half a century Sálim Ali has dominated Indian ornithology. It is difficult to think of any fields in which he has not made a significant impact, from education and conservation, collecting and regional surveys, papers on the ecology and ethology of Indian birds and numerous books, ranging from the popular to the authoritative HANDBOOK (written jointly with S. Dillon Ripley) in over 60 years' active association with the Bombay Natural History Society . . . . . . The autobiography gives us privileged insight into his personality. From its pages emerges a man of determination, almost ruthless in his pursuit of his chosen career, overcoming financial difficulties at a time when funds for field ornithology were very limited, the hardships of arduous field expeditions, and the obduracy of authority. . . . Although this is a book with a strong background of ornithology, I found some of the other aspects equally absorbing . . . . Autobiography is a difficult medium; clearly, it is restricted to those who have achieved some fame and it is easy to step over the boundary into self-adulation. Sálim Ali largely avoids this pitfall and the result is a most readable book that can be thoroughly recommended, not only for ornithological interest, but also for the insight it gives into Indian life and his shrewd comments on other well-known people.'

As the publisher of many of his books I was closely associated with Sálim for many years, and learnt much from him. He has told how hesitant I was to undertake the long-term project of the HANDBOOK, expected to be completed in ten years. But Sálim was already in the hands of various doctors, and Peters' CHECK-LIST OF BIRDS OF THE WORLD, started in 1931, though more ambitious, made slow

progress, only nine volumes by 1965 and still incomplete. But Sálim was always confident, and at his ninety-first birthday celebrations looked forward to reaching 100.

The *Ibis* notice was quite right in drawing attention to the non-ornithological aspects of Sálim's autobiography. Large parts of it rely on notes made by his companions, Meinertzhagen, Loke Wan Tho, Dillon Ripley in particular, and of course on his own accounts in the *Journal*. But in this place I must mention some defects of his qualities. His supreme self-reliance left little room for others, and in the Society he was during the past decade supreme: he could only accept help from his friends. He inspired imitation and devotion and accepted them without hesitation.

R. E. HAWKINS

MADHAV DATTATRAYA AGHARKAR
(1923-1988)

Madhav Dattatraya Agharkar was an efficient police officer. That was my first and most lasting impression about him. One October afternoon, four decades ago, sprightly and sedate, Agharkar was the Station House Sub-Inspector on duty at Paltan Road Police Station, situated to the north of the sprawling Victoria Terminus Railway Complex, when I entered the Charge-Room as a trainee sub-inspector. We trainees were being put through a programme of familiarization of practical police station working, before being posted out as regular full-fledged sub-inspectors. Paltan Road Police Station covered the area from Crawford Market to Prince of Wales' Museum, between Flora Fountain and the Harbour. The old Headquarters of the Bombay Natural History Society at Apollo Street occupied a significant spot in this area.

The flow of police work at Paltan Road Police Station in those post-war and post-partition years was the heaviest among the then 25 police stations in Greater Bombay. I came to be posted there in December, 1948 and was thus privileged to be a work-mate of Madhav Agharkar, who was main-stay and the backbone of the police team which bore the brunt of the onerous task. Agharkar had graduated in law before joining the Bombay City Police in 1943 and had been exposed to various hazards in Bombay Harbour and Docks in the crucial war-years in his first tenure as a young fledgling police sub-inspector at Yellowgate Police Station. Because of his creditable performance there, he was moved on his first regular transfer to the adjoining Paltan Road Police Station to tackle the arduous workload typical of that police station. Unflappable receptive attitude, immense patience, untiring confident demeanour and unshakable faith in one's ability to cope with the worst of situations were the hall-marks of Agharkar's way of life. This brought him success particularly against white-collar criminals. It was a valuable education and rich experience for me to follow, after working close with Agharkar for longer than two years.

After a short spell in the Special Branch of the CID Agharkar opted for deputation to a wider field for performance in the Special Police Establishment of Government of India in its Bombay Unit. In course of time, this grew into the formidable Central Bureau of Investigation and Agharkar went from success to success. He earned quick promotions and rewarding recognition. For a term, he was

transferred to Delhi and returned to Bombay Office of the Central Bureau of Investigation as a Deputy Superintendent of Police. He was awarded Police Medal for meritorious service and promoted as a Superintendent of Police. He continued to display his investigative skill in numerous cases and was therefore awarded President's Police Medal for distinguished service.

M. D. Agharkar retired from police service in 1981 after sterling performance spanning 38 years of a coveted career. He tried to go back to law but found the narrow-minded atmosphere prevailing at the bar stifling. He discovered the munificent legacy on Indian Natural History left behind by his uncle who was an illustrious naturalist, an ardent student of the flora and fauna of India. He returned to where he should have much earlier, from his police days of the late 'forties at Paltan Road Police Station — The Bombay Natural History Society.

Through another coincidence in 1981, I became a member of B.N.H.S. and we now came together at a non-police forum to our mutual delight. Agharkar soon earned a place of pride in his own right in the management sector of B.N.H.S. His approach to all proposals was studious, methodical and meticulous, habits cultivated during a long distinguished police career.

In the evening of his life, he had moved from bustling Bombay to the quite of Pune. He was not known to be ailing or to have any disease over his long healthy years of service. And yet, suddenly, in mid-March this year, we heard of Agharkar's sudden death at Pune. To this great and quiet personality, this is a last homage. R.I.P.

A. G. PATWARDHAN

REVIEWS

1. A MANUAL OF ETHNOBOTANY. Proceedings of the training course and workshop on ethnobotany held at Lucknow, 10-15 March, 1986. Edited by S. K. Jain. pp. i-vii + 1-228 (22 × 14.5 cm) with 4 Black-and-white plates. Jodhpur, 1987. Scientific Publishers. Price Rs. 125.00.

The editor of this book Dr. S. K. Jain is the Chairman of the international commission on ethnobotany and has studied the subject in its various aspects, both in the field as well as in libraries. Most of the topics in the book have been carefully selected by him giving information on concepts, scope, methodology and applications of ethnobotany.

Topics in the book have been handled by experts in their fields. To highlight the contents, I would like to enumerate the following few topics:

1. Ethnobotany — its scope and various subdisciplines by Dr. S. K. Jain (pp. 1-11).

2. Study of plants during ethnological research among the tribals by Dr. S. P. Gupta (pp. 12-22).

3. Interdisciplinary approaches in ethnobotany by Dr. J. K. Maheshwari (pp. 23-32).

4. Methods of research in ethnobotany by Dr. R. R. Rao and Dr. P. K. Hajra (pp. 33-41).

5. Ethnobotany and its role in domestication and conservation of native plant genetic resources, by R. K. Arora (pp. 94-109).

Workshop exercises deal with commendable practical programme. Some important topics are as follows:

1. Proformas for fieldwork (pp. 171-186).

2. Guidelines for project proposals (pp. 194-195), and hints for evaluation of project proposals (pp. 196-200).

3. Preparation of scientific papers (pp. 201-225).

The book is recommended for all field biologists. However, the price seems to be a little on the higher side.

M. R. ALMEIDA

2. REVIEW OF THE PROTECTED AREAS SYSTEM IN THE INDO-MALAYAN REALM. (Prepared for the IUCN/UNEP). By John and Kathy MacKinnon. pp. xii + 284 (29.5 × 21 cm), with many illustrations and maps. Gland, Switzerland and Cambridge, U.K., 1986. International Union for Conservation of Nature and Natural Resources. Price not mentioned.

In February 1985 a working session of IUCN's Commission on National Parks and Protected Areas (CNPPA) was held in the Corbett National Park, Uttar Pradesh (India), to focus attention on the protected areas of the Indo-Malayan Realm. Park professionals from 12 countries in the region met for the first time to review the status of conservation efforts being made in their respective countries. They recognised the need for an overall assessment of the adequacy of the protected areas system throughout the realm and hence the preparation of a systems review was included in the "Corbett Action Plan" adopted at this meeting.

The task of conducting, preparing and disseminating widely such a systems review, using modern biogeographic concepts, was assigned to the IUCN/CNPPA. The latter, in collaboration with the United Nations Environment Programme, engaged consultants John and Kathy MacKinnon to undertake this important work. The end-product, after more than two years of intense work by the consultants, is a two volumes review which has been just published and can be obtained from the IUCN Conservation Monitoring Centre, 219 C, Huntingdon Road, Cambridge, CB3 0DL, U.K., or the IUCN Publications Services, Avenue du Mont Blanc, CH-1196, Gland, Switzerland.

The first volume is the narrative part running into 284 pages and divided into five sections as follows:

Part One is the introduction, dealing with the objectives and criteria of Protected Areas; the aims and objects of the review undertaken; the Biogeography Theory and the Protected Areas System Designs; and the methods and approach of the review.

Part Two is mainly concerned with explaining the Indo-Malayan Realm: its physical limits, geological and biogeographical history, geography and physiography, climatic conditions, vegetation cover, floral and faunal characteristics, human history and man's impact on the environment in the region, etc.

Part Three deals with the protected area coverage by biogeographic units in the realm. For each of the distinct biounits, an assessment has been made of the total area protected and the extent of coverage of the main natural vegetation types. Particular attention has been paid to distinct habitats such as mangroves, swamp

forest, lowland rainforest, etc. The biological richness and endemism of each unit and the adequacy of protection of species of special interest has also been attempted. Further, major gaps in the protected areas systems has been identified and proposals made for extending and/or improving the current situation.

Part Four relates to general conservation issues of the realm like population pressure, threats to forests and wetlands, protection of critical habitats, species conservation needs, wildlife trade, and species coverage by reserves. This section is of special interest as it considers problems faced by both people and wildlife and the conflicts between the two.

Part Five is entitled 'Priorities for Country Action' and is thus of special importance. It reviews national protected area networks, on a country by country basis, and gives recommendations for extending and improving national reserve systems. Other conservation action has been recommended where appropriate and the responsible agencies identified. The countries included are: Bangladesh, Bhutan, Brunei, Burma, Southern China, Christmas Island and Cocos (Keeling) Islands, Hongkong, India, Indonesia, Japan (Southern Ryukyu Archipelago) Kampuchea, Laos, Malaysia, Maldives, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam.

The second volume contains detailed maps depicting the original vegetation types, the bio-geographical divisions, and the remaining forest and protected areas of the Indian, Indo-Chinese, Sundaic and Wallacean Sub-Regions.

The short and simple explanation of the whole exercise is that it seeks to examine the effectiveness of the current coverage of protected areas in the Indo-Malayan Realm as well as to identify the gaps and shortcomings and to indicate the action required for ensuring that samples of the Realm's biological diversity may be maintained for posterity.

The role of protected areas in maintaining essential ecological processes and life-support systems and preserving genetic diversity is well recognised. This role assumes special significance in the Indo-Malayan region, which presents one of the biggest paradoxes in conservation: it is the home of well over half of the world's human population as well as some of the richest and most distinctive ecosystems on Earth.

In this background, the Review presented by John and Kathy MacKinnon becomes specially relevant and topical. In another sense, it is work of a pioneering nature because this is the first time such a comprehensive coverage of the whole region has been attempted. Having travelled widely in the region and with their personal knowledge of the situation in some parts of South and South-East Asia, the MacKinnons have overall done a commendable job.

Here, however, two points need to be made. First, it should be noted that the Review is more or less confined to terrestrial protected areas and does not deal with the marine habitats of the realm. This does detract from the comprehensive coverage of the subject. However, as mentioned by the authors, earlier R. V. Salm and M. Halim had produced studies on the marine and coastal resources of the region. Secondly, the review has drawn heavily on preliminary drafts of the directories of protected areas of the realm under preparation, by the IUCN Conservation Monitoring Centre and such other data or information which has been made available in the last two years by various individuals and organizations from within and outside the region. Naturally,

there has been no time for any ground truth verification. Perhaps this is not even possible considering the nature and scope of the whole exercise. In any case, it is afterall an overview. Nevertheless, it is well to bear in mind that such an overview in bound to suffer from over-generalizations and that it can not possibly give equal and adequate treatment to every biounit. It is for this reason that, as stated by the IUCN President Dr. M. S. Swaminathan in his Foreward, "IUCN hopes that this will be viewed as a working document and that it will stimulate action at the national level. IUCN and UNEP indeed will promote national-level reviews of protection areas which will allow finer resolution and more detailed assessments."

As far as India is concerned, it is worthy of note that the Wildlife Institute of India, Dehradun, has already undertaken a much more detailed review of the Indian protected area system, also based on biogeographical considerations. This project, initiated under the Government of India's National Wildlife Action Plan adopted in 1983, has prepared a biogeographical classification for India on the basis of floral and faunal associations. Using this classification, the project is currently reviewing the location, size, viability and quality of management of all existing protected areas in the country and identifying new areas for protection status. A preliminary report shows that as yet many States have not reached the recommended goal of 5% land area proposed as conservation areas.

SAMAR SINGH

MISCELLANEOUS NOTES

1. IS *RHINOPOMA* A RHINOLOPHOID BAT?

(*With four text-figures*)

Current mammalian taxonomy, which is based mostly on morphological and anatomical characters, does not always reflect the phylogeny and interrelationships of the various mammalian taxa, since, in many cases, these characters are adaptive in nature. This is especially true of bats which possess unique morphological characters suited to a nocturnal flying habit and an inverted resting posture. In such cases only embryological characters can be utilised for determining the relative positions of the various familial and intrafamilial groups since other evidences such as from palaeontology, cytology, genetics and serology are not available at present. The importance of embryological characters for determining interordinal and intraordinal relationships of mammals was emphasised by Mossman (1937, 1953, 1971). More recently, Gopalakrishna and Karim (1980) and Gopalakrishna and Chari (1983) have shown that embryological characters are of considerable value in understanding the position and interrelationships of the various families of Chiroptera.

Most authors have considered Rhinopomidae as a primitive family and included it in the superfamily Emballonuroidea along with the family Emballonuridae (Dobson 1875, Simpson 1945, Koopman 1984, Hill and Smith 1985). Gray (1866) had, however, included *Rhinopoma* in rhinolophoids. Recently, Pierson (1985) adduced biochemical evidence to indicate that *Rhinopoma* is closer to Rhinolophoidea than to Emballonuridae.

The present paper is based on the documented studies on the embryology of two emballonurids, *Taphozous longimanus* (Gopalakrishna 1958, Wimsatt and Gopalakrishna 1958, Bhide and Bhatia 1981) and *T. melanopogon* (Sandhu 1986), two rhinopomids, *R. microphyllum* (*R. kinneari*) (Srivastava 1952, Gopalakrishna 1958) and *R. hardwickei* (Karim and Fazil 1986), one rhinolophid, *Rhinolophus rouxi* (Gopalakrishna and Bhivgade 1974, Bhivgade 1977), four hipposiderids, *H. bicolor pallidus* (Gopalakrishna 1958, Gopalakrishna and Moghe 1960), *H. fulvus fulvus* (Gopalakrishna and Karim 1975), *H. speoris* (Jeevaji 1982) and *H. ater ater* (Inamdar 1986) and one megadermatid, *M. lyra lyra* (Gopalakrishna and Khaparde 1978).

Figures 1-4 are schematic diagrams to illustrate the arrangement of the foetal membranes at full term of *Taphozous* (Emballonuridae), *Rhinopoma* (Rhinopomidae), and *Rhinolophus* (Rhinolophidae), *Hipposideros* (Hipposideridae) and *Megaderma* (Megadermatidae) respectively. The figures indicate that while in Emballonuridae there is a well developed haematoma on the mesometrial side of the uterus (an haematoma has been reported only in emballonurids among Chiroptera so far — Wimsatt and Gopalakrishna 1958) and a laterally located placental disc, in all the other families the placental disc is mesometrially located. In hipposiderid bats a central depression in the placenta gives it a bidiscoidal appearance in sectional views. The yolk-sac splanchnopleure in all the families except

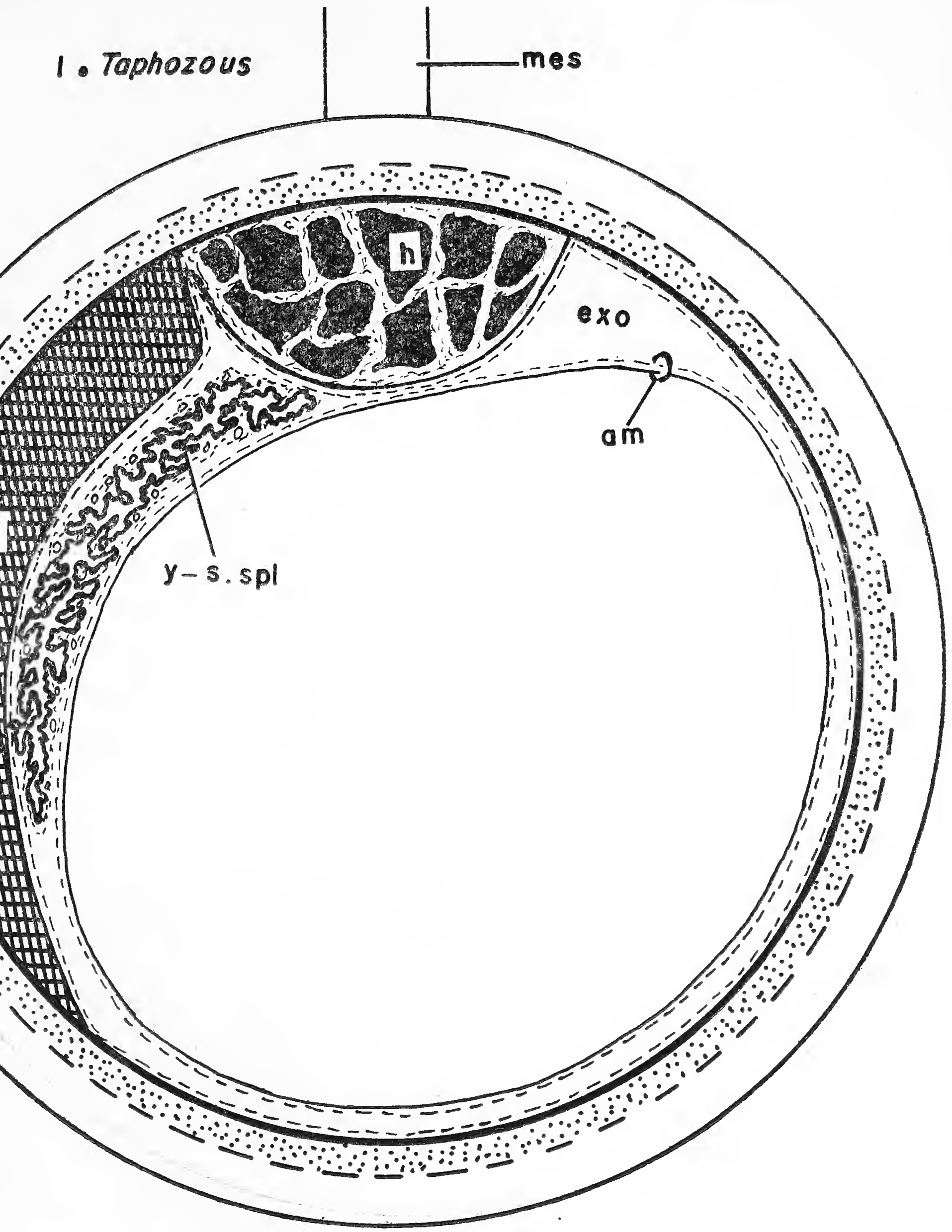

Fig. 1. Schematic drawing to illustrate the disposition of the foetal membrane at full term of *Taphozous*. Please see text for description.

Abbreviations

am, amnion; exo, exocoelom; h, haematoma; mes, mesometrium; pl, alanltoic placenta; y-s. spl, yolk-sac splanchnopleure.

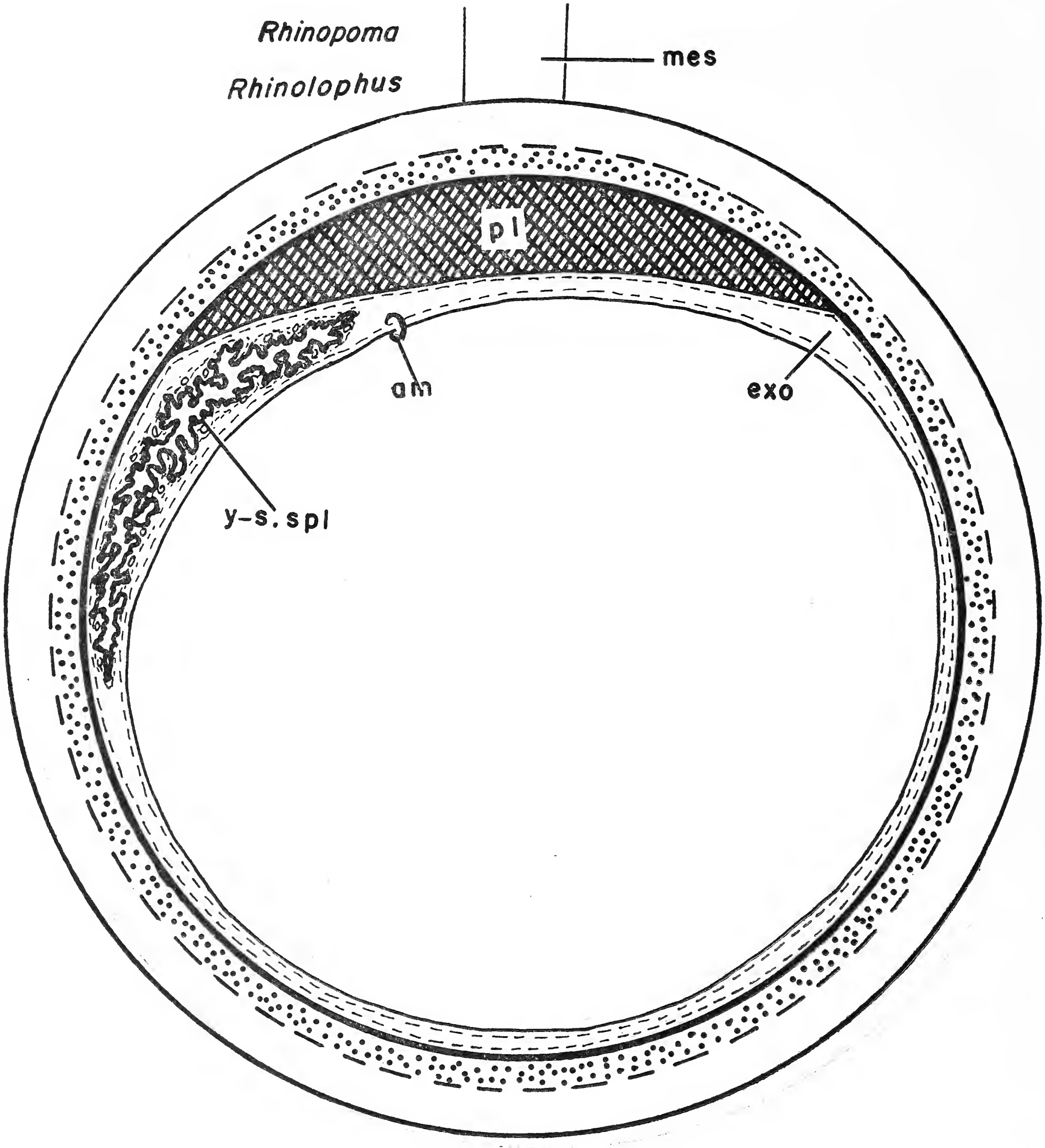

Fig. 2. Schematic drawing to illustrate the disposition of the foetal membrane at full term of *Rhinopoma* and *Rhinolophus*. Please see text for description.

Abbreviations

am, amnion; exo, exocoelom; mes, mesometrium; pl, allantoic placenta; y-s, spl. yolk-sac splanchnopleure.

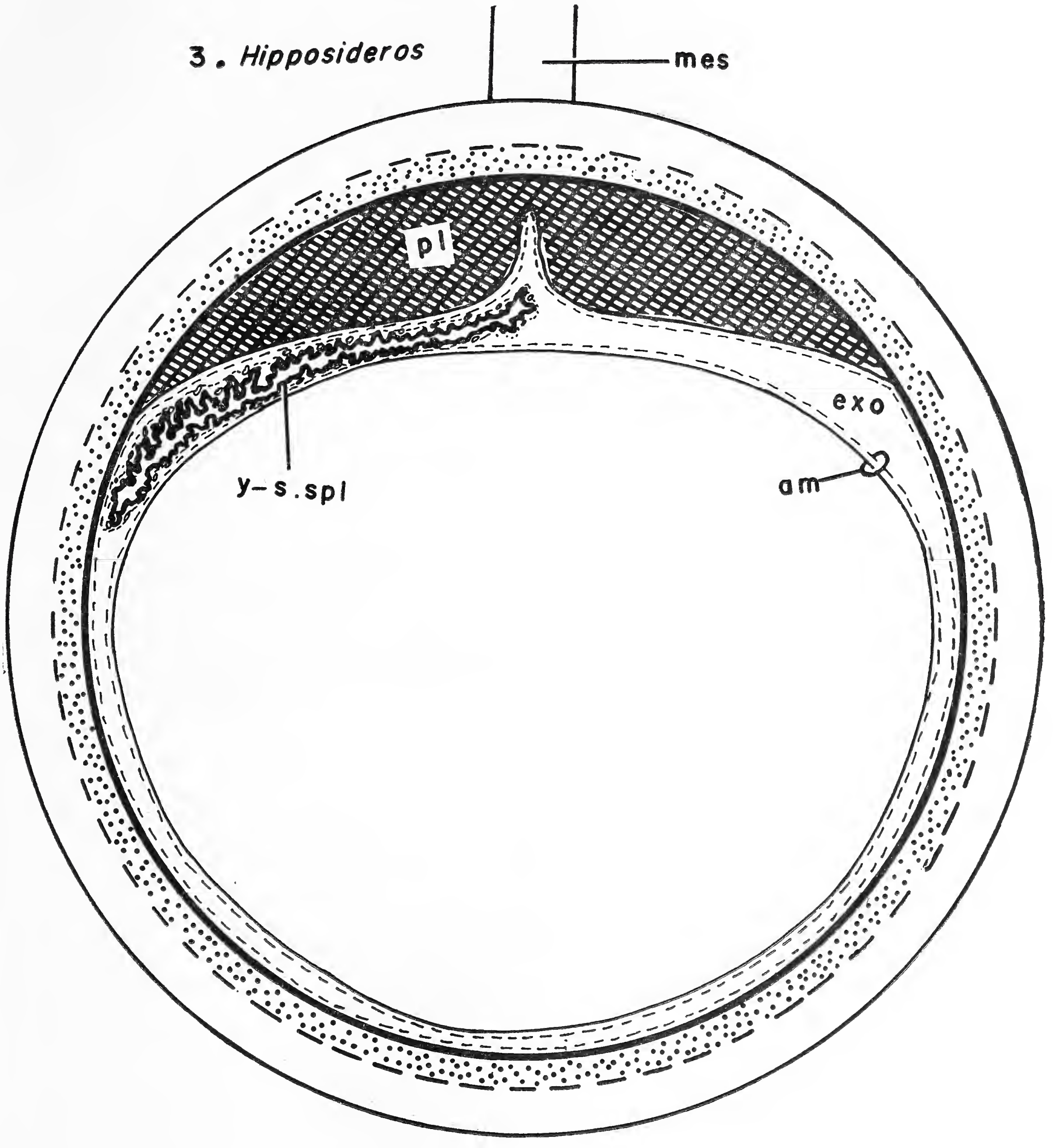

Fig. 3. Schematic drawing to illustrate the disposition of the foetal membrane at full term of *Hipposideros*. Please see text for description.

Abbreviations

am, amnion; exo, exocoelom; mes, mesometrium; pl, allantoic placenta; y-s. spl, yolk-sac splanchnopleure.

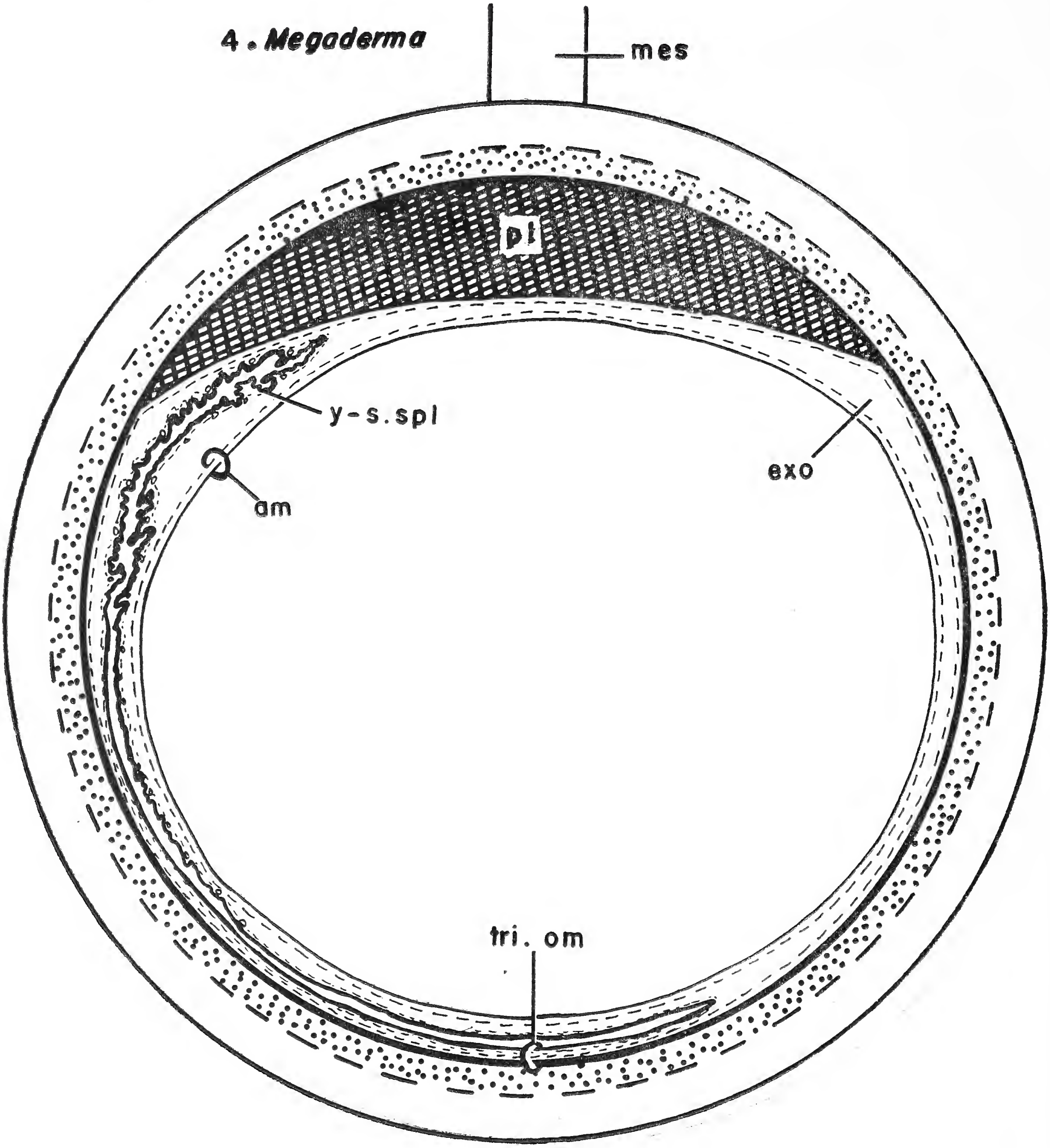

Fig. 4. Schematic drawing to illustrate the disposition of the foetal membrane at full term of *Megaderma*. Please see text for description.

Abbreviations

am, amnion; exo, exocoelom; mes, mesometrium; pl, allantoic placenta, tri. om: trilaminar omphalopleure; y-s. spl, yolk-sac splanchnopleure.

Megadermatidae lies freely in the exocoelom and is thrown into numerous folds. In *Megaderma* the abembryonic part of the yolk-sac splanchnopleure, however, retains its contact with the uterine wall.

The histogenesis of the placenta has been shown to occur in an unique manner in emballonurid bats. Whereas in all other bats the syncytiotrophoblastic mantle is formed by the proliferation from the basal cytotrophoblastic layer, in *Taphozous* a thick zone of large multinucleate trophoblastic giant cells is established after the blastocyst implants (Bhide and Bhatia 1981, Sandhu 1986) and the cells coalesce to form a syncytiotrophoblastic zone. Remnants of the endodermal allantois persist until full term in all the bats under consideration.

The above mentioned embryological details indicate that it is more justifiable to include *Rhinopoma* in Rhinolophoidea than in Emballonuroidea since the rhinopomids present more characters similar to the rhinolophoids than to Emballonuridae. Biochemical evidence in support of this contention is available through the work of Pierson (1985), who, by an immunological comparison of blood proteins, mentioned "1) *Rhinopoma* is no closer to emballonurids than are a number of other taxa (e.g.; vespertilionids, megadermatids, rhinolophids); 2) *Rhinopoma* associates with the rhinolophid clade, and within that group most likely with the megadermatids and nycterids."

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2. SOME NOTES ON THE BREEDING SEASON OF RUFOUSTAILED HARE (*LEPUS NIGRICOLLIS RUFICAUDATUS*)

It appears that the breeding season of rufoustailed hare has not been recorded precisely. Sabnis (1981) reports that the young may be found throughout the year, while Humayun Abdulali (pers. communication, quoted by Sabnis) has records of seeing pregnant females during December to March. Prater (1965) has not recorded any particular breeding season for rufoustailed hare.

In Keoladeo National Park, Bharatpur it appears the breeding season is mainly January to February, closer to the observation of Humayun Abdulali. Altogether four litters were seen, one each on 16 and 21 January, and 9 and 12 February 1987. No young was seen during the rest of the year.

Litter size of rufoustailed hare has been recorded as one to two (Prater 1965). One out of the four litters recorded at Bharatpur had three young, but the very next day of my observation (10 February) I found one young was missing, possibly preyed on as fur was seen scattered on the ground.

My thanks to Dr. V. S. Vijayan for encouragement.

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3. DERMAL SHIELDS OF HIMALAYAN TAHR (*HEMITRAGUS JEMLAHICUS*)

(*With a text-figure*)

INTRODUCTION

Recent field work on ungulate behavior and social organization has shown that competing males may injure their opponents in fights which establish dominance and determine access to females for breeding (e.g. Geist 1964, Clutton-Brock *et al.* 1982, Berger 1986). Many of these studies have also shown that such injuries may have long term effects on the competitive ability of males. Males should be expected, therefore, to possess effective defensive mechanisms as well as offensive ones. Defensive behavior is readily evident in the fighting behavior of many species. For instance, the head-low posture of South African oryx (*Oryx gazella*, Walther 1980), the scarcity of physical contact in mountain goats (*Oreamnos americanus*, Geist 1964), and the spinning around of Nilgiri tahr (*Hemitragus hylocrius*, Rice 1984), are all methods of minimizing the damage that can be inflcted by the opponent. Horns also have a defensive function, as is shown most clearly by South African oryx (Walther 1980). Dermal shields are another defensive mechanism which protect the body against injury from the horns or antlers of an opponent. Geist (1971) has shown how the thickness of the skin in several caprids is greatest in areas most likely to receive horn blows. The area of thickening is dependent on the method of fighting employed by a particular species (Geist 1971: 149). In addition, Jarman (1972) and Sokolov and Danilkin (1979) have shown how dermal shields are absent in hornless and anterless females and poorly developed in young males of impala (*Aepyceros malampus*) and roe deer (*Capreolus capreolus*) respectively. This paper describes the dermal shields of Himalayan tahr (*Hemitragus jemlahicus*) and suggests how they are related to the methods of fighting employed by this species.

MATERIAL AND METHODS

On 23 November 1986 a 5 year old male in the collection of Himalayan tahr at the New York Zoological Park lost a dominance fight with a previously subordinate male. The fight was not observed but the keeper in charge of the tahr had reported other fights during the few days previous. The male's condition deteriorated subsequently and he died after 13 days. Prior to necropsy, sections of skin were excised at several places and their thickness measured against a millimeter scale.

RESULTS

Examination of the body of the tahr showed numerous long scrapes on the side of the thorax, flank, and ventrum. Some of these had bled, but not severely. These minor external

injuries contrasted markedly with the extensive subdermal haemorrhages in these areas. The thickness of the dermis at various locations is shown in Fig. 1.

Discussion

The location and orientation of these injuries are consistent with the method of fighting in reverse parallel stance, in which the contestants stand parallel to each other facing opposite directions and delivering blows with the horns up and sideways into the body of the opponent. Dominance fights of wild Himalayan tahr have not been described in print, but observations on captive groups have included this type of fighting (Schaller 1978, Hassenberg 1981). According to Hassenberg (1981), the reverse parallel stance results when males follow through from a glancing frontal horn clash, after which the males hook back and up with the horns. Male Nilgiri tahr also fight in reverse parallel orientation (Rice 1984) and combine the horn blows with pushing shoulder to shoulder, a tactic which may be employed by Himalayan tahr as well.

The skin of the male Himalayan tahr was near maximum thickness on its ventrum and along the side of its rib cage, areas where it bore numerous scarpes, and where many of

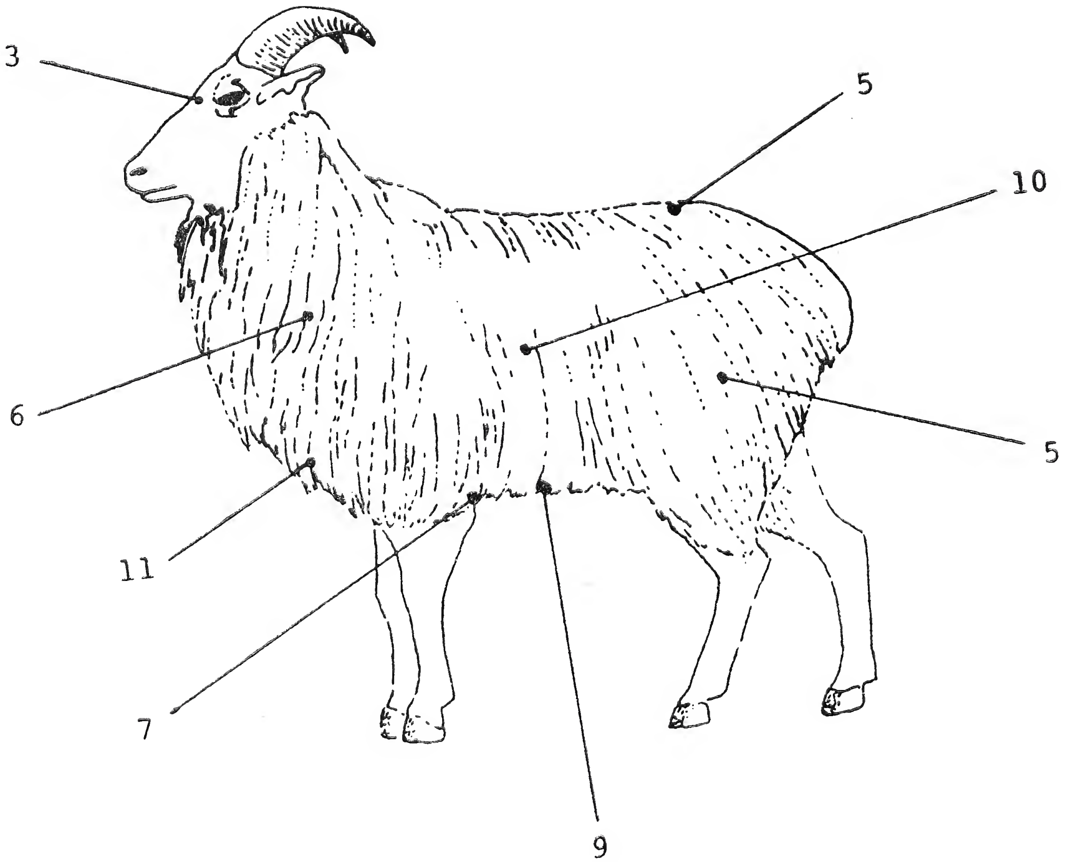

Fig. 1. Thickness (in mm) of 5 year old male Himalayan tahr skin at various locations.

the blows would be expected to fall when reverse parallel fighting. The lack of thickened skin on the rump contrasts with the situation in mountain goat which has its thickest skin in this area (Geist 1967). This corresponds to the fighting position of shoulder to shoulder in tahr, compared to the head to tail orientation of mountain goats (Geist 1964). The thickness of the skin on the chest of the male Himalayan tahr suggsts a need for protection for that area of the body, but few blows would likely be delivered there in reverse parallel fighting. Perhaps quick hooks following frontal clashing would, and further observations of dominance fights in Himalayan tahr may bear this out.

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4. A SHORT NOTE ON A NEW FOUND GROUP OF TAHR

This is a report on an isolated pocket of Nilgai Tahr (*Hemitragus hylocrius*) in the southernmost reaches of the Western Ghats in the Veerapuli range of forests in the district of Kanyakumari in Tamil Nadu. The Tahr is found in four adjacent hillocks, locally called Varaiadu Mottai (Tamil for Tahr Butte). These hills at 8° 26′N and 77° 22′E reach an altitude of about 3,000 feet (*c.* 1000 m). The area can be described as montane grassy hill tops with riverine gallery forests on its slope and base. The Nilgiri Tahr inhabits mainly the steep cliffs that form part of the topography of the area. The hills overlook the Pechipara reservoir to the northwest and Perunchani reservoir to the south. The next nearest herd to these hills lives in the Pechiparai cliffs and Kalamali hills more than a distance of 20 km separates them.

In the last seven years I have made many

visits to this location for the purpose of photographing and observing Tahr. The total population in all the four cliffs will be about 30 to 35 animals. At any single time I couldn't count them according to population composition of age and sex class. At each peak I used to find a herd of about 10 or 11 females with one saddleback in attendance during the mating season, or groups of males in twos and threes separately. I have observed their feeding pattern to follow a schedule. The animals actively graze till about 9 a.m. after which they rest or retreat to the rocky cliffs and also adjacent Shola forests and reappear after 3 or 4 p.m. back at their grazing grounds. Once I saw them deep inside the wooded area taking shelter from buffeting wind during a rainstorm. On three separate occasions I saw three adult males bed down for the night in rocky crevices with overhanging vegetation. In fact one very old saddleback was killed by a poacher in one of these crevices in the night. Local poachers know of this habit and go searching for them in such hide-outs. However, it is also known that Nilgiri Tahr grazes along with village cattle that is driven up the hills during summer months. They show hardly any fright even when the cattle are accompanied by man. The herd usually has a sentinel female, which despite sighting me did not leave its post, but had me in its sight for about 45 minutes, watchful of course, ready to sound the alarm if the need arose. Rice (1986) remarks that the Nilgiri Tahr does not have twin births, but the female if it loses its kid may mate again and have a second kid during the same season. However in February 1986 I observed two young kids of same size tagging behind one female for more than an hour. I realize this is a one-time observation.

In short, what I have observed is an isolated population in one of the southernmost reaches of the western ghats. They are cut off from other herds of Tahr in many ways, mainly by the effects of man, plantation, dams, hydel projects and roads. It would be interesting to study this small herd in more detail to see the effects on their genetics through breeding in isolation. I suggest that this herd be protected from further ravages of man. The loss of even one more herd, however, small it may be, to dams and plantation, which have disturbed them most in this area, will be a grevious loss to the existing population. Poaching is on the increase now. Very recently a saddleback was shot dead.

ACKNOWLEDGEMENTS

I wish to express my gratitude to Dr. E. G. Silas for helping me prepare this draft and Mr. M. Krishnan for giving helpful hints on photography and to both of them for all the encouragement and guidance given.

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5. BLACKBUCK BEHAVIOUR AND HORN SIZE

Since July 1986 we have been looking into the herd structure of the Blackbuck at Rehakuri Sanctuary, Maharashtra. In the mixed herd there was one large male with both its horns broken. Though its horns were not more than 6 to 10 inches long, it was indeed one of the dominant males and seemed to command great respect despite the short stumpy horns.

After the next rut he was seen along with

the bachelor herd. However, he was still domineering and quite a bully. He persistently attacked any other male nearby. The other bucks always gave way and allowed 'Broken-horns' to chase them out of the area.

This went on for several months. However in April 1987 'Broken-horns' began to lose ground. Apparently the other males had now discovered that his aggressive approach to life was a ruse which he was using to cover up his inadequacy due to the short blunt horns.

By May 1987 'Broken-horns' was being chased by small males and even by young bucks with small horns. The bully seemed to have come on really hard times. He was being persecuted by several animals in the male herd, and had to run as hard as he could when chased. He hardly ever made the effort to lock horns and spar any longer. The route was completed within a period of one year, and he is now often seen all by himself.

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June 6, 1987.

ERACH BHARUCHA
K. ASHER

6. AN OBSERVATION ON THE RELATIONSHIP BETWEEN A SAMBAR AND A TREE-PIE

While on a trip to Sariska in November 1986 I saw a Sambar hind standing on 3 legs in an awkward position. The rear leg on the far side was lifted up and away from her body. My first impression was that the animal was wounded in some way. However, a moment later a tree-pie flew out from under her groin and settled on her back. At this the hind lowered the leg and promptly lifted the rear leg on the near side. The tree-pie instantly flew under her and could be seen picking off something from her skin. The tree-pie was evidently feeding on parasites living in the fold below her leg. The interesting part of the observation is that the ungulate was not a passive partner, but had invited the bird to feed in her ingiunal region by actually raising the leg.

'SAKEN' VALANTINA SOCIETY,
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June 6, 1987.

E. K. BHARUCHA

7. THE BLACK STORK *CICONIA NIGRA* (LINNAEUS) IN KURNOOL DISTRICT (ANDHRA PRADESH)

According to Ali & Ripley (1983), the southernmost distribution of the Black Stork *Ciconia nigra* in the Indian subcontinent is *c.* 18°N latitude (i.e. Solapur district of Maharashtra) and it has not been recorded from South India, and only once in Sri Lanka.

At Rollapadu, 20 km east of Nandikotkur town (15°52′N & 78°18′E) in Kurnool district, where the BNHS has a field station under the Endangered Species Project (Great Indian Bustard), two Black Storks were first seen on 7th November 1985, and after that two to a maximum of six birds were regularly seen till December 1985. Enquiries from local shikaris revealed that this stork is a regular winter visitor every year in this part of the state.

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REFERENCE

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8. SIGHTING OF RED-NECKED GREBES (*PODICEPS GRISEGENA*) ON THE PONG DAM LAKE, HIMACHAL PRADESH

We visited the Pong Dam Lake on 2 December 1985 as part of a survey to assess the potential of the lake for the creation of a bird sanctuary. Our survey included a trip by motor launch which covered the southwestern end of the lake, adjacent to the dam. During the course of this boat trip we observed two Red-necked Grebes (*Podiceps grisegena*) about 500 m from the shore and 1 km from the dam, in an area where the water depth probably exceeds 50 m.

In shape and size the birds resembled Great Crested Grebes (*P. cristatus*), with tall, slender necks and long, tapering bills. They differed from that species mainly in the coloration of the breast and sides to the neck which were dusky brown instead of white. The crown was black and made a strong contrast with the white cheeks, but at the minimum range at which we observed them (80 m) we could not discern the exact pattern of black and white around the eye. However, the extent of black on the face appeared greater than is seen in a winter-plumage Great Crested Grebe. The plumage of the two birds was similar.

Both birds took flight at the approach of the launch, becoming airborne with great difficulty after pattering along the surface for a considerable distance. In flight they showed a double pale bar on the wing. One of us (AJG) is familiar with Red-necked Grebes on the Pacific coast of Canada and was able to identify the birds immediately.

This record appears to be the first for Red-necked Grebe in India. The second edition of the HANDBOOK (Ali and Ripley 1979) includes the species for the sub-continent on the basis of a record from Nammal Lake, Pakistan, in the Punjab Salt Range, a little over 300 km west of the Pong Dam. Otherwise the species

breeds sparingly throughout most of the northern Holarctic, wintering in temperate latitudes, mainly in marine inshore waters. The closest place where the species winters regularly is the southern end of the Caspian Sea (Cramp 1977).

The size of the Pong Dam Lake (about 7000 ha when full) and its situation in the extreme northwest of lowland India, make it very suitable to intercept migrants entering the plains from central Asia. In addition to the grebes we saw about 10,000 ducks, mainly Mallard (*Anas platyrhynchos*), with some Pintail (*A. acuta*), Gadwall (*A. strepera*), Teal (*A. crecca*) and Pochard (*Aythya ferina*), and moderate numbers of waders, particularly Temminck's Stint (*Calidris temminckii*), Redshank (*Tringa totanus*), Greenshank (*T. nebularia*) and Green and Common Sandpipers (*T. ochropus* and *T. hypoleucos*). We also saw several Blackheaded and Great Blackheaded Gulls (*Larus ridibundus* and *L. ichthyaetus*), species which are otherwise rare in Himachal Pradesh. Further observations, particularly during the migration period, should yield many more species.

Any birdwatchers visiting the area are encouraged to contact the Divisional Forest Office at Dehra, at the western end of the lake, for information. In due course the Himachal Forest Department hope to provide facilities for observing birds on the lake, including access paths and observation towers.

We would like to thank the management of the Pong Dam for putting their motor launch at our disposal.

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S. PANDEY

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9. SOME ASPECTS OF BEHAVIOUR OBSERVED IN THE GREATER FLAMINGO AT BHIGWAN

On 27th June, 1985 I accompanied Mr. Humayun Abdulali on a field trip to observe the Greater Flamingos at Bhigwan on the Pune-Sholapur road. I have been visiting the area for several years, but what was noteworthy throughout 1985 was the large number of juveniles constituting a fair proportion of some flocks.

This indicates that though the 'Flamingo City' in the Great Rann is not where it used to be, they are breeding at some other unknown place. During this trip on several

occasions we saw the brownish young ones approach adult birds with their heads dipped, and bills open, while they croaked anxiously. The adults then apparently fed them, but we could not see what was being passed from bill to bill.

On the 26th March, 1986, one of our members Shri Digveerendrasinh Solanki and I observed a fascinating aspect of Flamingo behaviour.

On this visit there were approximately a thousand birds scattered over the shallows. Just after dawn there was a large aggregation in an isolated creek in the distance. The activity appeared frantic. On carefully approaching the birds it was observed that there were several groups in the centre of the flock engaged in picturesque corporate displays.

Seven or eight would come together wagging heads and croaking loudly. They would all bring their heads together, their bills nearly touching, in a tight circle. As their calls became louder they would erect the long feathers on their backs like huge white and pink lotus flowers.

The noisy activity would stop as suddenly as it had begun, to be repeated either in an adjacent group, or a few minutes later in the same one.

This activity continued periodically between bouts of feeding between 7 A.M. and 10 A.M. when they moved off into another area nearby.

It remains to be seen if this heralds a migration northwards to their breeding grounds in Kutch, or the remote possibility of setting up a colony at Bhigwan itself.

ERACH BHARUCHA

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10. OCCURRENCE OF THE FALCATED TEAL *ANAS FALCATA* (GEORGI) IN KHIJADIA BIRD SANCTUARY, GUJARAT

On 24th December 1984 around 4.30 p.m. while walking along the Jheel bund which is situated in front of the Khijadia salt works pump house, we saw to our surprise six Falcated Teals (*Anas falcata*) 3 males and 3 females feeding together. The male can be easily identified by Bronze-green, purple head and the long sickle shaped feathers falling over the closed wing, whereas the female with dull brown colour, has the speculum edged with white. The Falcated Teal is a rare winter vagrant to India, less rare in Burma and the Shan states and common throughout the Indo-Chinese countries (THE BIRDS OF KUTCH p. 164). The Maharao Vijayarajji of Kutch shot a bird on 7th February, 1932 in Kutch (*JBNHS 35*, pp. 899). There is only one record of its occurrence in the neighbouring province of Sind (ibid. *14*, p. 149). So this is the second sight record of Falcated Teal in Gujarat after a gap of nearly fifty two years.

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ASAD AKTHAR

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11. THE SCAUP DUCK (*AYTHYA MARILA*) IN MADHYA PRADESH

The Scaup Duck (*Aythya marila*) is a rare winter visitor to the Indian sub-continent, though it has been sporadically recorded from Kashmir, Kulu, Punjab, Delhi, Nepal, Uttar Pradesh, Bihar, West Bengal, Bangladesh, Assam, Manipur and Maharashtra (HANDBOOK p. 188). Recently during our ringing programme at Karera Bustard Sanctuary, Shivpuri district, Madhya Pradesh, one of us (VN) had the opportunity of handling a Scaup Duck caught by our trappers along with ducks of different species. This particular bird was identified as an adult male.

Wing — 221 mm; Bill — 43 mm; Tarsus — 37 mm; Tail — 55 mm; Wt. — 1080 g. All the primaries had freshly moulted.

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V. NATARAJAN
R. SUGATHAN

12. SIGHTING OF THE BLACKCRESTED BAZA (*AVICEDA LEUPHOTES*) AT BHIMASHANKAR

On the 1st January, 1986, at 1040 hrs., we sighted a blackcrested baza (*Aviceda leuphotes*) at Bhimashankar (District: Pune; 19°4′N, 73°32′E). The bird was soaring over the canopy at Hanuman Tale, occasionally flapping its wings between glides. At that distance we were unable to differentiate between *A. leuphotes leuphotes* and the East Himalayan *A. leuphotes syama.*

If it was *A. l. leuphotes,* then this sighting is a new record for Maharashtra. It is supposed to be resident in Kerala including Wynaad and the Nilgiri Hills and may be resident in Coorg and the Malnad area of Karnataka, though it has yet to be recorded in the latter area (Ali and Ripley 1978). If it was *A. l. syama,* then it was probably a passage migrant to or from Sri Lanka. It is. however, surprising that an East Himalayan bird should use a western migratory route. As the status and distribution of the two races is as yet unclear (Ali and Ripley 1978), further information would be of much interest.

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ULHAS RANE
RENEE BORGES

REFERENCE

ALI, S. A. & RIPLEY, S. DILLON (1978): Handbook of the Birds of India and Pakistan. Vol. I. Oxford University Press, Bombay.

13. RECENT SIGHTINGS OF THE SANDWICH TERN (*STERNA SANDVICENSIS*), WITH COMMENTS ON ITS STATUS IN GUJARAT

(*With a text-figure*)

After Dharmakumarsinhji (1958) first recorded a Sandwich Tern *Sterna sandvicensis* in its winter plumage in May 1958, near Veraval on the west coast of Gujarat, there were no records of the bird from Indian waters until an individual ringed in Russia was recovered from Kerala in March 1976 (Ambedkar 1985). Lal Mohan (1986) reports on the collection of three birds, one from Rameshwaram island, Tamil Nadu, in September 1983 and two others from Mandapam, also in Tamil Nadu, in June 1983 and November 1983 respectively. From Sri Lanka, a single ring recovery has been recorded (Ali and Ripley 1983). This tern is, however, known to be a common winter visitor to coastal Pakistan (Ali and Ripley 1983).

The Sandwich Tern is slightly larger than the Gullbilled Tern *Gelochelidon nilotica,* sleek in build, with a yellow tipped slender black bill that is visible at a close range only. In India, a majority of these birds have been seen in their winter plumage, which consists of a black nuchal tuft, white crown streaked with black, grey wings and mantle, a white underside and forked tail. When viewed casually, the Sandwich Tern can be mistaken for the Gullbilled Tern, and Ambedkar (1985) suggests this as a possible reason for the lack of additional records from India.

TABLE 1

A SUMMARY OF THE SIGHTINGS OF THE SANDWICH TERN IN GUJARAT

Location no.[1] and place	Date	Habitat type	No. of birds	Observer[2]
1. New Port, Jamnagar	1.ii.1986	tidal creek	1	T.M.
2. Pirotan	–.xii.84	island	1	S.K. and L.K. (pers. comm.)
3. Ashapura	18.vii.84	saltpan	1	S.T. and T.M.
4. Man merodi	5.i.87	island	2	S.K., L.K. and T.M.
5. Bet Dwarka	26.iii.86	island	4	R.P. and T.M.
6. Okha	15.x.84	seacoast	3	S.K. and L.K. (pers. comm.)
7. Veraval	19.v.58	mouth of river	1	Dharmakumarsinhji (1958)
8. Vanakbara[3]	26.i.87	tidal creek	52	A.S. and T.M.
9. Diu[3]	26.i.87	tidal creek	63	A.S. and T.M.
Diu[3]	6.vi.86	tidal creek	6	N.J. and T.M.
10. Nayabunder	25.i.87	seacoast	43	A.S. and T.M.
11. Simor[3]	25.i.87	seacoast	16	A.S. and T.M.

[1] The locations are designated by the same numbers as in Figure 1.

[2] A.S. — Anil Shetgaonkar, L.K. — Lavkumar Khacher, N.J. — Narendrasinh Jhala, R.P. — Rishad Pravez, S.K. — Shivrajkumar Khachar, T.M. — Taej Mundkur.

[3] These locations are in Diu district, which is under the jurisdiction of the Union territory of Goa, Daman and Diu.

In the last few years, the Sandwich Tern has been sighted in a number of places on the coast of Gujarat (Table 1 and Figure 1). The most recent sightings were made on an approximately 30 km coastline, covered on 25 and 26 January 1987 (Table 1), when flocks of upto 63 birds were observed with other birds, namely Gullbilled Tern, Caspian Tern

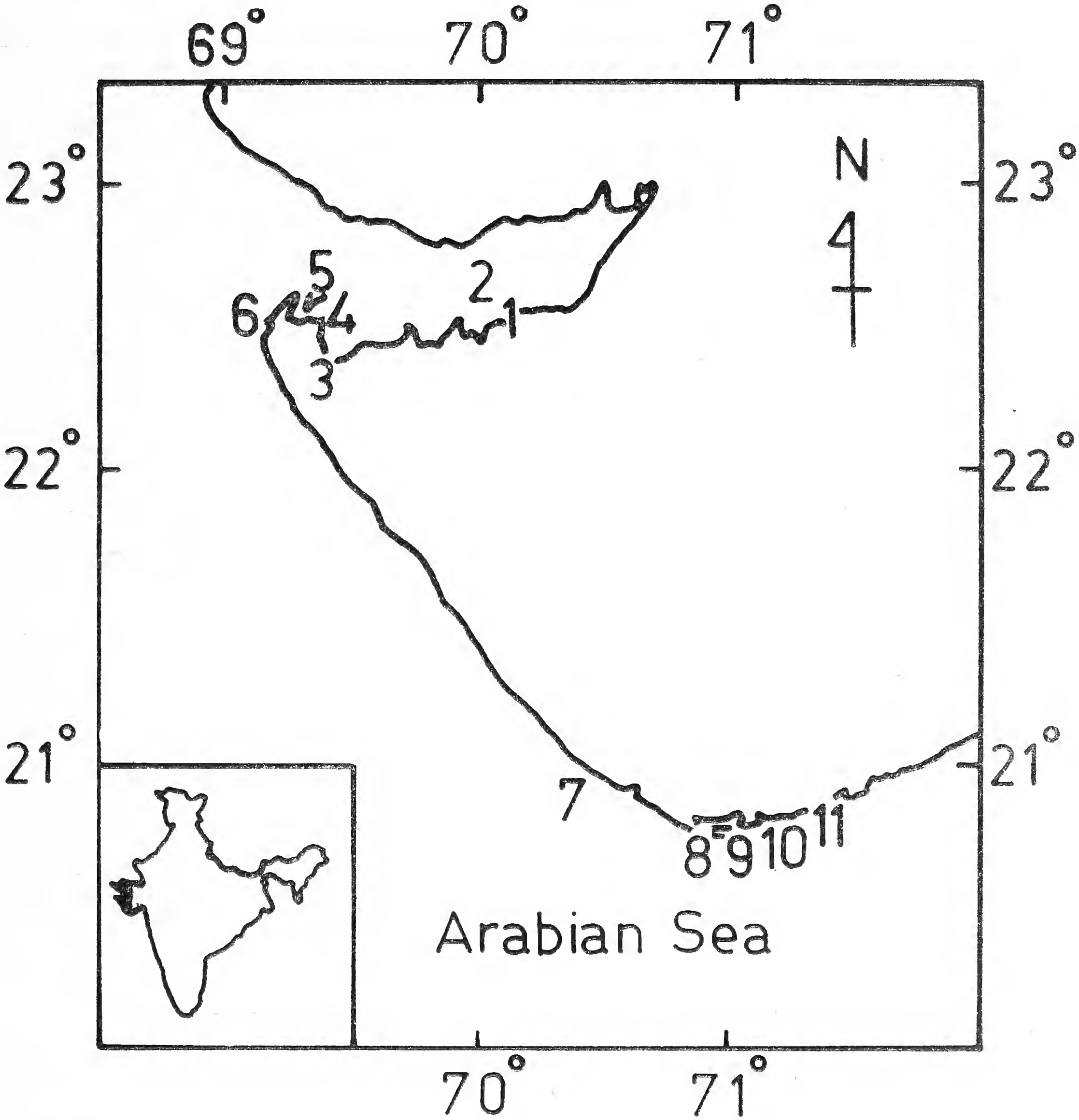

Fig. 1. Sight records of the Sandwich Tern in the study area in Gujarat. Locations are designated by location numbers as explained in Table 1.
(Inset gives the map of India with the study area shaded in black).

Hydroprogne caspia, Lesser Crested Tern *Sterna bengalensis*, Little Tern *Sterna albifrons*, Herring Gull *Larus argentatus*, Brown-headed Gull *Larus brunnicephalus* and Black-headed Gull *Larus ridibundus*, resting on sand bars and rocks exposed during the low tides. One of the Sandwich Terns had an alluminium ring on its right tarsus.

The Sandwich Terns observed between May and July (Table 1) were probably sub-adults overwintering here. It is known for the European nesting population (Moller 1981) that many first year, some second year and third year birds spend the summer in their winter quarters in Africa, the birds maturing and breeding first only at the age of four years.

At Diu, when we observed the birds in summer, they were among a few thousand other terns, namely, Common Tern *Sterna hirundo*, a majority of which were juveniles and some adults in winter plumage, Caspian Tern, Whiskered Tern and Gullbilled Tern in winter plumage and Little Tern in summer plumage. This observation indicates that the Diu creek may be important for overwintering Laridae.

Repeated sighting of the Sandwich Tern in Gujarat strengthens the view that the bird is a more frequent visitor along the coast of western India than what the earlier scant records indicate.

ACKNOWLEDGEMENTS

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14. A NOTE ON THE FIRST DISCOVERY OF THE NEST AND EGGS OF THE ASHY-HEADED BABBLER *GARRULAX CINEREIFRONS*, AN ENDEMIC SPECIES OF SRI LANKA, IN 1984

According to A HISTORY OF THE BIRDS OF CEYLON Legge (1880), *Garrulax cinereifrons* was first discovered by Dr. Kelaart in 1852, and it is recorded in "Annotated Checklist of the Birds of Ceylon (Sri Lanka)", Phillips (1978) that its breeding was then still un-

known. A total of 132 years have therefore elapsed between the discovery of the species and the first authenticated discovery of its nest and eggs in March/April 1984.

While observing birds in the Morapitiya Forest Reserve, situated adjacent to the Sinharaja Forest, and about 40 miles south-east of Colombo, we discovered the commencement of nest building by *Garrulax cinereifrons* in the undergrowth on a fairly steep hillside carrying some quite tall trees. The discovery was made at about 8.30 a.m. on the 25th March, 1984. The first indication of possible nest building was when one bird was seen to pick up a large dead leaf from the ground and fly away with it. By careful observation, a succession of birds were found to be depositing the leaves, and a few twigs, in a fork of a small sapling, and about 15 ft from ground level. The rapidity with which the birds arrived to make a deposit suggested that, perhaps, the whole flock might contribute towards construction, and this was indicated when three birds made a leaf deposit within a space of less than 60 seconds.

The nest, commenced in the morning of 25th March, was probably completed by the end of the month, and the first egg was probably laid on or about the 1st April because, when we returned to the forest and looked into the nest at 11.00 a.m. on the 3rd April, using a mirror fastened to a long pole, and a pair of binoculars, Mrs. Judy Banks obtained a "first sight" of three turquoise blue eggs. The colour and number of eggs were subsequently confirmed by Dr. T. S. U. de Zylva (at that time President of the Wildlife and Nature Protection Society of Sri Lanka) who also later succeeded in measuring one egg at 25 × 18 mm. The blue eggs of this endemic species probably places it in the *Garrulax* genus.

In the construction of the nest, the birds had deposited an untidy mass of leaves and twigs in the fork of the tree to form a base the size of a football, and the nest cup was set into the top of that mass. The inner diameter of the cup was $3\frac{1}{2}$ inches and it was largely constructed of pliable twigs, rootlets and horse-hair lichen with a few *Cullinia ceylonica* leaves at the base — probably part of the leafy foundations (which were not recovered when the nest was collected).

It was not possible to keep the nest under constant observation due to other commitments, but brooding appeared to commence in the late evening of the 3rd April and when the nest was next visited on the 19th April, it was found to contain only one newly hatched chick. The other two eggs or chicks were absent and are presumed to have been predated. The visit of 19th April was immediately followed by a period of heavy rains which flooded and damaged approach roads, but a Land Rover finally succeeded in getting through to the nest site on the 24th April. The nest was found to be empty and it can only be assumed that the third chick had been predated. The nest was collected and has been lodged at the National Museum, Colombo.

We acknowledge, with grateful thanks, the information contributed by Dr. T.S.U. de Zylva, and we also thank Dr. W. S. Kotagama for assisting in the identification of the materials used in the construction of the nest, and for assistance in finalising these notes.

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15. SEPARATION IN THE HAND OF WHITEBROWED BLUE FLYCATCHER *MUSCICAPA SUPERCILIARIS* AND SLATY BLUE FLYCATCHER *MUSCICAPA LEUCOMELANURA*

Familiarity with these two species allows easy separation but until that familiarity is acquired, the problem of identifying females and first year birds can be a tricky one exacerbated by two factors. The first is the lack of illustrations of the birds except of breeding plumage adults — for example Ali and Ripley (1983). Ali, Ripley and Dick (1983) and Fleming, Fleming and Bangdel (1979). The second is that the key in Ali and Ripley (1983) can be difficult or confusing to use. For example, part of key suggests the third primary equals the fourth in *M. superciliaris* and that the third is shorter than the fourth in *M. leucomelanura.* While ringing at Haigam Rakh, Kashmir in September 1984, two first year *M. superciliaris* were caught — one male and one female. In both specimens the third primary was 1 mm shorter than the fourth.

To confirm the identification and to look for a sure way of separating the two species, an examination was made of the skins in the British Museum (Natural History), Tring, England. A total of 47 *M. superciliaris* and 20 *M. leucomelanura* was examined. Birds collected between June and September were ignored because of the possibility of the presence of not quite fully grown primaries.

Comparison of the third and fourth primaries produced the following.

M. superciliaris:
3rd primary = 4th primary: 34%
3rd primary shorter than 4th: 63.8%
3rd primary longer than 4th: 2.1%

M. leucomelanura
3rd primary shorter than 4th: 100%

The two species can however be separated by wing point, i.e. the longest primary. Figures in brackets refer to the number of birds.

M. superciliaris — wing point is between 3rd and 4th/5th primaries as follows on the skins examined:

wing point =	3rd primary	(1)
	3rd and 4th primaries	(14)
	3rd, 4th and 5th primaries	(2)
	4th primary	(28)
	4th and 5th primaries	(2)

Thus 89.4% of the birds had a wing point of either the 3rd and 4th primaries or the 4th primary.

M. leucomelanura — wing point is either the 5th primary (15) or 5th and 6th (5).

When the 3rd primary is shorter than the 4th, the two species can still be separated by measuring the difference.

M. superciliaris — range: 0.5-2.5 mm.
mean: 0.82 mm.

M. leucomelanura — range: 2.5-4.0 mm.
mean: 3.03 mm.

To summarise, *M. superciliaris* and *M. leucomelanura* can be separated in the hand by reference to the wing formula. In *M. superciliaris* the wing point falls between the 3rd and 4th/5th primaries — usually 3rd/4th or 4th. When the 3rd primary is shorter than the 4th it is usually (90% of the birds) only 0.5 or 1.0 mm shorter. In *M. leucomelanura* the wing point is always either the 5th primary or 5th/6th primaries. The 3rd primary is always shorter than the 4th and by at least 2.5 mm.

ACKNOWLEDGEMENT

Thanks are due to Derek Reed of the British Museum (Natural History), Tring, England for his help.

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16. FURTHER NOTES ON GARHWAL BIRDS: GREY FACED LEAF WARBLER (*PHYLLOSCOPUS MACULIPENNIS*)

Little is known about the breeding distribution of western race of the Greyfaced Leaf Warbler (*Phylloscopus maculipennis*). According to HANDBOOK (Vol. 8) it is found from Kashmir to Kumaun but the altitudinal distribution and habitat in summer have not been recorded, and this race has only been described from winter quarters.

While trekking from Dodital to Kedarnath on an expedition, partially sponsored by the Society I had kept special lookout for the species of *Phylloscopus.* On 7th June 1985, at Belak (alt. 10,000′) Tehri Garhwal District, I came across one feeding in a medium sized tree, 15 feet above me. I had excellent views of the bird, in good light, and satisfactorily identified it as Greyfaced Leaf Warbler (*Phylloscopus maculipennis*). It can be confused with *Phylloscopus proregulus* at a casual glance, but the grey face and throat and the bright yellow of the underparts were distinctive. I found about 5-6 scattered birds, possibly holding territories, in the Oak forest around the village. They all seemed to prefer foliage of the medium sized oak trees.

Given the date it seems quite possible that *Phylloscopus maculipennis* was breeding in this area. This sighting thus is worth placing on record.

NITIN JAMDAR

3 ROCKY HILL,
MALABAR HILL,
BOMBAY 400 006,
July 20, 1985.

17. BEHAVIOUR OF *PLOCEUS BENGHALENSIS*

During July 1984 I did a small experiment to study the encroachment behaviour of nest building cocks at village Tatar Pur (27°47′N, 76°31′E) in Alwar District of Rajasthan. I selected three colonies of Blackbreasted Baya (*Ploceus benghalensis*) which were present on *Saccharum munja* at three different patches in same locality. I tied a few leaves of host plant in the form of a bundle by tearing some strips from the leaves of the same plant near the nest of one of the male birds. After a few hours when I examined the bundle of leaves, I was surprised that it had been opened by the cock. I did the same experiment with other two nest building cocks and got the same results. This observation clearly indicates that male Blackbreasted Baya cannot tolerate nest initiation by other males within his territorial limits.

SATISH KUMAR SHARMA

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GULAB BAGH,
UDAIPUR-313 001 (RAJ.),
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18. *PLOCEUS MANYAR* (HORSFIELD) RECORDED IN KUTCH

Mr. Shantilal Varu and other members of the Pelican Nature Club of Kutch reported to me that they saw a Streaked Weaver in the bed of Khari Nadi, a river couple of kilometres west of Bhuj. When I went personally to investigate this report, I saw 5 + of these birds on May 17, 1985, in the riverbed and two males were busy with a couple of nests in the helmet stage woven in the leaves of the reeds. I was informed that there were some more of these weavers farther down the river. This bird has not been recorded in Kutch.

The above-mentioned gentlemen also told me that they saw a pair of Chestnut Bittern and some Blackheaded Munia in the same riverbank; but I did not see these. The latter are obviously escapees from a cage, for this part of the country is quite outside their area of distribution.

HIMMATSINHJI

JUBILEE GROUND,
BHUJ, KUTCH,
March 13, 1986.

19. NOTES ON THE BIOLOGY OF *MELANOCHELYS* (REPTILIA, TESTUDINES, EMYDIDAE) IN THE TERAI OF NEPAL

Two species of *Melanochelys* occur on the Indian subcontinent, but their presence in Nepal has remained unconfirmed. The black turtle, *M. trijuga,* is common and widespread, with scattered populations in the southern half of India and others centred in the Bengal area. The keeled hill turtle, *M. tricarinata,* is much less common and confined to the Bengal-Assam area (Smith 1931, Das 1985). Recent investigations into the ecology of rhinoceros and their forage species in the Terai of central Nepal (Royal Chitwan National Park, RCNP, vicinity of Sauraha) have revealed the presence of *Melanochelys* in Nepal and several aspects of its biology.

Occurrences and abundance

Recently, Moll and Vijaya (1986) reported the occurrence of both *Melanochelys tricarinata* and *M. trijuga* from the northwestern corner of the state of Bihar, India, adjacent to the Chitwan area of Nepal. This close proximity suggested that both species probably also occur in RCNP, and Moll and Vijaya saw photographs of a *M. tricarinata* supposedly taken in RCNP. We can confirm that *Melanochelys* does occur in RCNP, although those observations with confirmed species identification are all *M. trijuga.* All sightings of *Melanochelys* have been in grassland habitats at the edge of rhino wallows, in short Shiru (*Imperata cylindrica*) grassland and in flood-plain grassland (authors' observations; J. Lehmkuhl and R. Shrestha, pers. comm.). In some instances, the sighted turtle was within 30 m or less of the forest edge, yet none have been observed in the forest. This habitat preference seems real, because examination of the forest floor is easier than viewing the soil surface in the grasslands. A *M. trijuga* (shell) was obtained in the Terai zone of western Nepal (Royal Bardia Wildlife Reserve, vicinity of Thakurdara) as well.

Melanochelys has been observed most frequently in October-November and once in February. These data show that they are active during the first half of the dry season. Activity may be reduced during the last half of the dry season, because the grasslands are heavily burned and no turtles are visible after the fires nor have any turtles been seen with fire-scarred shells. All turtles observed have been adults or large juveniles.

Melanochelys trijuga seems to be relatively common in RCNP and vicinity, although we can provide no estimate of relative abundance or as yet confirm the presence of *M. tricarinata.* Our observations have been made secondarily to other field investigations and no intense search has been made. Dinerstein has begun to individually mark these turtles, so estimates of abundance will be possible in the future. Shells of *Melanochelys* and *Indotestudo elongata* are found in refuse dumps, seemingly common enough to serve as an occasional food item for the local human population.

Reproduction

Incubating eggs of *Melanochelys* have been found twice, each time buried in grassland latrines of the greater one-horned rhinoceros (*Rhinoceros unicornis*). The first clutch was discovered in March, 1985 and consisted of three oblong eggs (46.8 × 27.5 mm, 49.1 × 26.7 mm, 51.3 × 27.6 mm); the shells were thin, firm and calcareous. Two eggs were opened and no embryos were apparent. A second

clutch of six egg was found 15 November 1985. They are equal in size to the first clutch; length — mean 47.4 ± 2.3 mm, range 44.6–50.7 mm; diameter — 27.4 ± 0.6 mm, 26.7–28.3 mm; weight — 21.6 ± 0.6 g., 20.6–22.3 g. None of these eggs contained embryos. This clutch was buried in the latrine at a depth of approximately 30 cm; the latrine was 3 m on its longest axis and sat on a tall-grass clump of Baruwa (*Saccharum benghalensis*). The specific identity of these eggs is uncertain; both species have similar-sized eggs but different clutch numbers, 1-3 eggs in *M. tricarinata* and 3-8 eggs in *M. trijuga* (Das 1985, E. Moll, pers. comm.).

Adult size and growth

The *M. trijuga* shell found in the Bardia area was 114 mm carapace length (CL) and 110 mm plastron length (PL). A 1.2 kg adult female *M. trijuga* from Chitwan was 215 mm CL and 186 mm PL with a maximum carapace width of 150 mm and a maximum height of 83 mm. This female possessed seven distinct scute layers in addition to the hatchling scute on each plastral plate. This datum suggests that she was at least seven years old, and measurements of pectoral scute layers indicate a 43 mm PL at hatching and an average annual growth rate (PL) of 20.4 mm per year.

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20. *KACHUGA* (REPTILIA, EMYDIDAE) IN NATIONAL CHAMBAL SANCTUARY: OBSERVATIONS ON DIURNAL NESTING EMERGENCES AND UNSUCCESSFUL NESTING CRAWLS

(*With a text-figure*)

Data presented here refer to the period 30 October 1983-5 July 1985 during which we undertook 120 whole-day trips to the field for 'turtle-studies'.

Diurnal nesting emergence:

Kachuga species in Chambal usually nest in the night. Occasionally, nesting may be seen upto 1000 Hrs. in the morning or at as early as 1600 hrs. in the afternoon. Local villagers normally notice those turtles which come out for nesting at dawn or dusk. During 8 of our 120 field-days, we recorded 11 turtles (Table 1) which had nested or had attempted to nest during the day. *K. tentoria* were caught when these were moving away from the water. *K. dhongoka* were found inexplicably lying upside down on the sand bank. Captures of *K. kachuga* were possible because of our speed-boat with which we approach the turtles before these returned to deep water.

In all the above cases the conclusions were made that the turtles had emerged for nesting because of the following (ref. Table 1).

a) Located the nest with eggs	Sl. nos. 2, 7.
b) Found on a nesting bank. Oviducal eggs collected and/ or eggs 'released' by turtle after capture	Sl. nos. 1, 3, 4, 5, 8, 10.
c) Found on or close to a nesting bank during the nesting season. Adult females. Released after marking	Sl. nos. 9 and 11

The minimum temperature during diurnal emergence in December ranged from 3.5° to 9.0°C while the maximum day-time shade temperature was 28°-38°C. During the peak nesting season of *K. dhongoka* and *K. kachuga* when nocturnal nesting is the rule, the minimum and maximum temperatures are 16.2°C-36.9°C (March) and 21.6°-40.1°C (April) (Fig. 1).

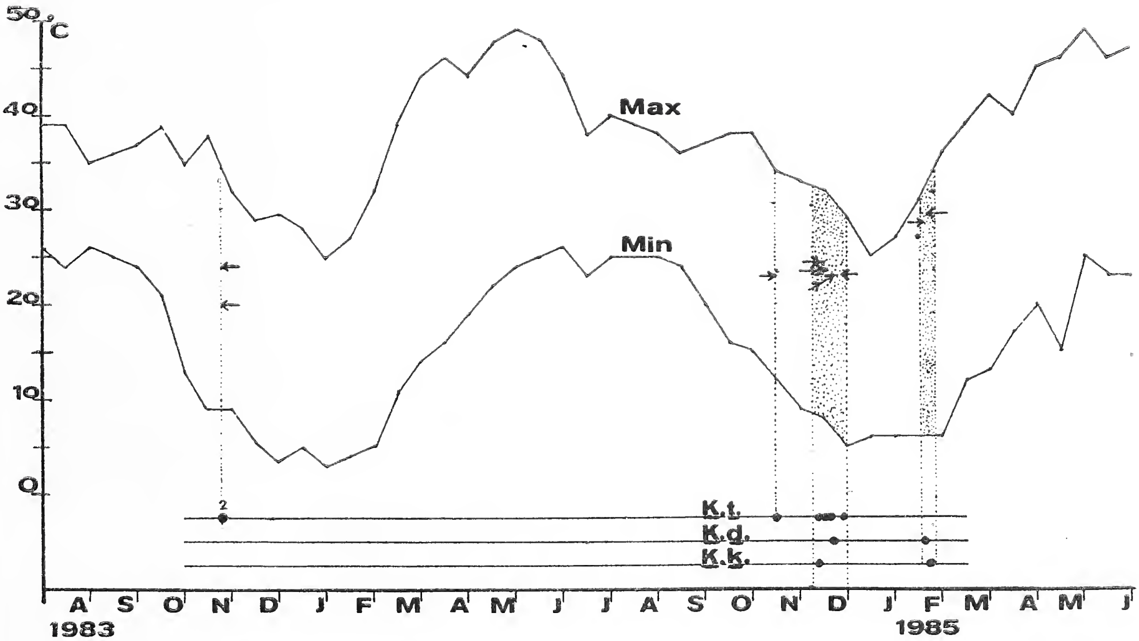

Fig. 1. Diurnal nesting emergences (dots) in *Kachuga tentoria* (*K. t.*), *Kachuga dhongoka* (*K. d.*) and *Kachuga kachuga* (*K. k.*) shown against date and shade temperature (small arrows). The curves show the fortnightly maximum (Max) and minimum (Min) shade temperature recorded at the camp. The number '2' against a dot shows two emergences for the species on the same date.

TABLE 1

DATA ON TURTLES CAPTURED DURING DIURNAL NESTING EMERGENCE. TEMPERATURES REFER TO THE TIME OF CAPTURE

Sl. No.	Date Day/ month/ year	Carapace length (mm)	Place	Distance (Km)*	Time (hrs.) nesting/ capture	Temp°C Air (shade)	Temp°C Water (30 cm deep)	Remarks
Kachuga tentoria								
1.	24.11.83	250	Rohu	113	0730	20.0	21.0	Unsuccessful nesting attempt. Found 6 oviducal eggs.
2.	24.11.83	230	Batesura	123	1600	24.0	21.0	Successfully nested. Collected 7 eggs from the nest.
3.	15.11.84	250	Baroli	57	1140	23.0	22.0	Unsuccessful nesting. attempt. Found 9 oviducal eggs.
4.	13.12.84	185	Ranipura	307	1300	23.5	20.5	Unsuccessful nesting attempt. Found 5 oviducal eggs.
5.	15.12.84	205	Udi	352	1530	24.5	21.0	Unsuccessful nesting attempt. Found 3 oviducal eggs.
6.	17.12.84	235	Kenjra	296	1630	23.5	21.5	Unsuccessful nesting attempt. Found 8 oviducal eggs.
7.	27.12.84	224	Papripura	213	1400	23.0	20.0	Successfully nested. Collected 5 eggs from the nest.
Kachuga dhongoka								
8.	17.12.84	415	Khera Azab Singh	362	1130	23.0	20.0	Found upside down on a sand bank 10 m away from water. Turtle dropped 17 eggs in the tank to where it was shifted. One egg in left oviduct.
9.	19.2.84	460	Barotha	79	1600	28.5	22.0	Found upside down on a sand bank 18 m away from water. Marked and released.
Kachuga kachuga								
10.	13.12.84	560	Kenjra	296	1200	23.0	20.0	Found very close to water (0.5m). started dropping eggs during transit to pen, 100 km. away. Total 17 eggs (incl. 5 from left oviduct).
11.	20.2.84	540	Rohu	113	1500	29.5	23.5	Found 4 m away from water. Marked and released.

* In reference to Palighat (Parbati-Chambal confluence) in the upstream.

Unsuccessful nocturnal nesting crawls:

During our early morning check, we have observed 31 night crawl marks of turtles which led out of water (that could be only for nesting) but returned without egg laying (Table 2). Eighteen such crawl marks on a potential nesting site were accompanied or superimposed by jackal tracks. The tracks of the jackal (egg-predator) were seen for the entire length of return track of the turtle and only a part of the onward track. Such instances are viewed to be interference from the predator due to which the turtles did not nest.

TABLE 2

UNSUCCESSFUL NOCTURNAL NESTING EMERGENCES

Species Track	No. of instances	Probable reason for not nesting
SMALL TURTLE		
(*K. tentoria*)	3	Unsuitable Ground.
	11	Pursued by jackal.
LARGE TURTLE		
(*K. dhongoka* or	9	Unsuitable Ground.
K. kachuga)	1	Rain (a half-dug nestpit located).
	7	Pursued by jackal.
Total	31	

DISCUSSION

Although dusk to dawn is the time for nesting by *Kachuga* species in Chambal, diurnal nesting may also occur. Such diurnal nesting may be related to the turtles' temperature requirement and/or a turtle's past experience of repeated harassment during nesting crawl by an egg-predator. These aspects need further study.

Jackals are the main predators of turtle eggs in Chambal. The instances recorded in the above regarding aborting a nesting attempt due to interference by egg predator are rather rare and raises questions like — 'how is a turtle's nesting emergence related to predator activity? When a predator is 'busy' in following a turtle expected to nest, is it advantageous to other nesting females? How can these aspects be qualified?

ACKNOWLEDGEMENT

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21. NEW LOCALITY RECORD FOR THE INDIAN PEACOCK SOFTSHELL TURTLE *TRIONYX HURUM*

Three species of softshell turtles (Family: Trionychidae) in the genus *Trionyx* are known to occur in India. These include the Indian softshell turtle *Trionyx gangeticus* Cuvier from the rivers and reservoirs of northern India and the Leith's softshell turtle *Trionyx leithii* Gray from the southern Indian rivers and reservoirs. The distribution of the third species, the Indian peacock softshell turtle *Trionyx hurum* Gray, is generally given as the lower reaches

of the Brahmaputra and Ganga (Pritchard 1979, Smith 1931). Mertens (1969), also quoted by Khan and Mirza (1976), had recorded the species from lower Sind, in Pakistan. Moll and Vijaya (1986) reported it from the West Champaran district of northwestern Bihar, near the Nepal-Uttar Pradesh border. One specimen of *T. hurum* was collected by me from Bhopal, Madhya Pradesh and the material deposited at the National Zoological Collection, Zoological Survey of India, Calcutta.

Trionyx hurum Gray

Material: 1 ex., collected from Lower Lake, Bhopal, Madhya Pradesh. 2 December, 1986. Coll. I. Das. ZSI Reg. No. 24408.

Measurements & Weight: Median straight carapace length (bony shell & soft disc.) 138 mm, carapace width 112 mm, plastron length 106 mm, weight 234 gms.

Description: Carapace olive-green with four well defined ocelli. Head and forelimbs grey-black with large yellow patches; one yellow spot behind each eye, one across snout and one on top of each corner of the upper jaw. Numerous small yellow spots on the forehead and on the dorsal surface of the forelimbs, the undersurface of which has yellow patches. Hindlimbs grey with cream spots. Plastron cream. The present record suggests that *Trionyx hurum* may be found in other isolated north Indian freshwaters.

I thank Dr. John G. Frazier, Smithsonian Institution, Washington, D.C., for comments on an earlier draft of the manuscript.

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22. VEGETATION IN THE FOOD CONTENTS OF GARDEN LIZARD (GIRGIT), *CALOTES VERSICOLOR* (DAUD.) (REPTILIA: AGAMIDAE)

Calotes versicolor (Daud.) — the common garden lizard (girgit), is predominantly an insectivore (Bhatti *et al.* 1985). While assessing the food preference of this lizard, undigested or slightly digested pieces of small to fairly large (0.001-15 mm) herbaceous plants were observed in the stomach contents of more than 25 individuals of different age and size. The vegetational components of stomach matter, on comparison with the flora of the areas, showed

following plants: shisham (*Dalbergia sissoo*), rose (*Rosa indica*), kikkar (*Acacia* sp.), cotton (*Gossypium* sp.), munj (*Saccharum munjo*), jawar (*Sorghum*), shahtoot (*Morus alba*), cyanodon (*Cyanodon* sp.), kochia (*Kochia* sp.), rat-ki-rani (*Sestrum nocturnum*), din-ka-raja (*S. alba*), etc. In one of the stomach of garden lizard minute bits of flower parts of wild aak (*Calotropis procera*), mako (*Solanum nigrum*), baigan (*Solanum melongena*), rose, chinese rose (*Althea rosea*), malvestrum (*Malvestrum* sp.), gulmohar, bougainvillaea, etc, were also noticed. In order to know the digestibility of vegetation, *Calotes* was fed in captivity, on the young and fresh leaves of above noted species (plants); the lizards however showed neither orientation nor feeding preference for them. The plant components were apparently swallowed along with the prey species being captured. This perhaps occurs because of the peculiar habit of *Calotes*, especially the male, to sample all sorts of strange objects that come across their path.

Our studies on the garden lizard, *Calotes versicolor* (Daud.) revealed that individuals of this species do not eat plants and are not specialized for vegetative diet

The present study was conducted at Hansi (Haryana) and Bulandshar (U.P.), during May-June, 1983-84, and 1985 respectively.

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July 25, 1986.

UJJAL SINGH BHATTI
S. KAUR BHATTI
SURJEET SINGH BHATTI

Reference

Bhatti, S. Kaur, Bhatti, U. S. & Saran. H. M. (1985): Behavioural aspects of garden-girgit *Calotes versicolor* (Daud.) (Agamidae: Reptilia). II. Food preference investigated through the stomach contents. *Proc. 2nd N. E. Acad., Faizabad*. 19-20.

23. ON THE SYSTEMATIC STATUS OF *DANIO* (*DANIO*) *MENONI* BARMAN (PISCES: CYPRINIDAE)

Barman (1985) described a new cyprinid fish, *Danio* (*Danio*) *menoni*, collected from a stream near Mosampet village, Mahbubnagar district, Andhra Pradesh, based on three specimens (one holotype and two paratypes). He gave a key to the identification of the species of the genus *Danio* (*Danio*) and adjusted *Danio* (*Danio*) *menoni* in the key. While revising the fishes of the subfamily Rasborinae, the description and figures of *Danio* (*Danio*) *menoni* appeared peculiar to us and we were doubtful whether this species was a representative of Rasborinae. In order to confirm the systematic status of this species, type material in the fish section of Zoological Survey of India, Calcutta was examined in detail; the type material of this species was identified by us as *Chela* (*Chela*) *laubuca* Hamilton belonging to the subfamily Cultrinae. The description and the figure of this species in the published account agrees exactly with the type material and also with *Chela* (*Chela*) *laubuca* Hamilton. Barman (loc. cit.) was misled to describe this material as a new species of the genus *Danio* because of his wrong placement of the material under another subfamily

(Rasborinae) and the genus (*Danio*), both of which clearly differ from the subfamily Cultrinae and the genus *Chela*. The presence of a keeled abdomen from the pelvic origin to the anal aperture, the distinctive black shoulder spot and elongated outer pelvic ray are characteristic features of the genus *Chela* (subfamily Cultrinae), and these features are present in the type material of *Danio menoni*. Barman (loc. cit.), however, overlooked the presence of a keeled abdomen in his material. The description of *Danio* (*Danio*) *menoni* Barman is a result of wrong identification at the subfamily and generic levels and this species should fall in the synonymy of *Chela* (*Chela*) *laubuca* Hamilton.

ACKNOWLEDGEMENT

We are grateful to Director, Zoological Survey of India, Calcutta for encouragement.

ZOOLOGICAL SURVEY OF INDIA,
218, KAULAGARH ROAD,
DEHRA DUN,
May 12, 1987.

RAJ TILAK
SEEMA JAIN

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24. NEW RECORD OF *CRYPTOTERMES HAVILANDI* (SJOSTEDT) FROM RAJASTHAN, INDIA (ISOPTERA: KALOTERMITIDAE)

Cryptotermes havilandi was originally described from Fernando Po and Boma (Cameroons, Congo) by Sjostedt (1897) on the basis of imago. Subsequently it has been found to be a very widely distributed species recorded from Oriental, Ethiopian, Neotropical and Malagasy regions. In the Indian subcontinent, it has been recorded from Bangladesh, Sri Lanka and India (Kerala, Karnataka, Madhya Pradesh, Orissa, West Bengal, Assam and Andaman Island) (Chhotani 1970). This species was collected on 29th August 1984 in Southern Rajasthan at Tamatia village, *c.* 7 km west of Banswara. The colony was attacking the central dead portion of a giant uprooted tree of Mohwa (*Madhuca indica* J. F. Gmel.). With this record the range of this species extends to further west in Rajasthan.

Measurements (in mm.) (soldier): Total body length with mandibles 5.0-5.20; Head length to lateral base of mandibles 1.22-1.28; Maximum length of head to frontal ridge 1.20-1.36; Median length of head up to frontal ridge 0.94-1.10; Maximum width of head 1.16-1.24; Maximum height of head 0.86-1.02; Maximum length of labrum 0.13-0.22; Maximum width of labrum 0.17-0.28; Length of mandibles 0.64; Maximum length of pronotum 0.86-0.92; Maximum width of pronotum 1.15-1.20; Number of antennal segments 13-14.

I thank the Director, Zoological Survey of India, Calcutta for encouragement and facilities and Dr. R. K. Varshney, Deputy Director, Desert Regional Station, Zoo-

logical Survey of India, Jodhpur for useful suggestions. I am also grateful to Dr. M. L. Roonwal, Ex-Director, Zoological Survey of India for confirmation of identification.

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JODHPUR - 342 006,
February 13, 1986.

N. S. RATHORE

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25. SCIENTIFIC VERSUS POPULAR NAMES OF BUTTERFLIES

Sevastopulo (1986) has questioned the value of the common or popular names of butterflies. He has apparently given two reasons — that few butterflies are of economic importance, and that in India learning of English common names of butterflies is as difficult as that of scientific names. Independently Murphy & Ehrlich (1983) have also opined against the use of common names by lepidopterists. I humbly disagree. In the 'Introduction' of my publication (Varshney 1983) referred to by Sevastopulo, I have explained in detail both pros and cons of the value of common names. Without repeating, I may briefly state that while the necessity and usefulness of zoological nomenclature of a species stands undisputed, the practice of citing common English names for the mammals, birds, butterflies and flowering plants etc. has also served immensely useful purpose since a very long time. Most of the natural history writings are a proof of it. A number of responsible bodies, e.g. The Entomological Society of America, have desired and released approved list of common names. Regarding the economically important groups it is only the common or popular name of the pest that matters. Not only are the latinized scientific names hard to learn, the frequent changes in their generic or species epithet are really bothersome. In the case of many insects such changes could be sustained only on account of their well-known common names. I have cited example of a species 'The Common Rose' for which not less than 13 different scientific names have been used during the last 80 years (Varshney, l.c.).

Sevastopulo has further felt that I have 'added considerably to the confusion' in the common names of butterflies. How can it be, when out of 1,150 total entries, I have suggested 14 changes only? Besides, reasons were given for each and every change. He states, "Eggfly seems a meaningless name for the two Indian species of *Hypolimnas*". It is incorrect, for I have mentioned two separate names 'Danaid Eggfly' and 'Great Eggfly' for *H. misippus* (Linnaeus) and *H. bolina* (Linnaeus) respectively (page 17). The late Wynter-Blyth (1957) reported that the name 'Admiral' is a corruption of 'Admirable' the old English

traditional name (page 212 of his book). 'Tortoiseshell' has been added in one case, to uniformly distinguish all *Nymphalis* species. I feel that any name is good enough, whether common or scientific, if it helps recognition and maintains uniqueness and stability.

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26. STUDIES ON THE INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITY ON ADULT LONGEVITY, OVIPOSITIONAL PERIOD AND FECUNDITY OF THE RICE MOTH, *CORCYRA CEPHALONICA* (STAINTON) (LEPIDOPTERA: GALLERIIDAE)[1]

INTRODUCTION

The rice moth, *Corcyra cephalonica* (Stainton) is a storage pest of oil seeds and cereals with a wide distribution in subtropical and tropical areas. This species is frequently imported into temperate regions with produce such as rice, rice bran, groundnuts and cocoa beans originating from Southeast Asia and West Africa and to a lesser extent from South America (Freeman 1973). The development of *C. cephalonica* on stored products has been studied by several authors. Its life cycle in United States was briefly reported by Chittenden (1919). Krishna Ayyar (1934) described the adult and immature stages and gave an account of its biology and developmental period on different foods under Indian conditions. The rice moth has gained importance in India in recent years mainly on account of its use as laboratory host for rearing many insect natural enemies which are being tried in biological control of crop pests. Reports on the effect of temperature and humidity on the development of *C. cephalonica* are mainly due to the studies made by Sheshagiri Rao (1954), Kamel and Hassanein (1969) and Teotia and Singh (1975). However, there is little information available to date on the development of this insect under controlled conditions on stored sorghum. It is important to know the behaviour of this insect under different combi-

[1]Part of the M.Sc. Thesis submitted by senior author to the University of Agricultural Sciences, Bangalore.

nations of temperature and humidity so that the same can be employed for effective mass multiplication under laboratory condition. An attempt was therefore made to know the effect of temperature and relative humidity on adult longevity, ovipositional period and fecundity of the rice moth at controlled temperature and humidity conditions which are presented in this contribution.

Material and Methods

Constant temperatures of 15°, 20°, 25°, 30°, 35° and 40°C were maintained during B.O.D. incubators. At all these temperatures, relative humidities varying from 30 per cent to 90 per cent (with an increase of 15 per cent) with saturated solutions of salts as per Winston and Bates (1960) were provided. Freshly laid eggs were collected and kept at different temperatures and relative humidities. Insects were reared from egg to adult stage and observations made in respect of adult longevity, ovipositional period and fecundity of the rice moth, at an interval of six hours.

Eggs were incubated at various temperatures and relative humidity conditions in groups of ten in glass tubes (5×1.25 cm). Immediately after hatching, larvae were released in plastic containers (5×5 cm). Fresh food material was supplemented as and when it was necessary. The culture was maintained on broken sorghum grains (CSH-1) in plastic containers at a temperature of 28°C and relative humidity of 90 per cent. On emergence, the moths were allowed to mate and a pair in copula was collected for further studies on fecundity and longevity. All the studies were made in four replications and the data collected was subjected to logit transformations as suggested by Finney (1952), and statistically analysed using the method of analysis of variance.

Results and Discussion

The results of the present experiment carried out to determine the development of different stages of the pest under various temperature and humidity conditions have been presented in Tables 1-4. The average longevity of adult male and female together varied from 3.11 days at 35°C to 11.94 days at 15°C. The average duration of full life is longest i.e., 120.04 days at 15°C followed by 83.43 days at 20°C, 53.22 days at 25°C, 38.64 days at 30°C and 35.57 days at 35°C (Table 4). The average adult longevity significantly increased with an increase in humidity and decreased with increase in temperatures (Table 1).

There was no development of any stage of the insect at 40°C.

Effect of temperature and relative humidity on fecundity and ovipositional period

The results obtained on oviposition period and fecundity under the set of experimental conditions, as stated earlier have been presented in Tables 2 and 3. The oviposition period was generally higher at higher humidities, for each temperature except at 35°C. It was significantly highest at 15°C and 90 per cent relative humidity (Table 2). So far as the fecundity of the insect is concerned (Table 3), higher values have generally been obtained at temperatures of 15° and 20°C with 90 per cent relative humidity and also at 25° and 30°C with a relative humidity ranging from 75 per cent to 90 per cent, there being no difference in fecundity between these two temperature groups.

Among the temperature and humidity, the former influences the development whereas humidity affects the fecundity.

The present study has indicated very clearly that fecundity is a major factor responsible for rapid build up of population of the insect under any set of temperature and humidity

conditions. In the present case, a temperature between 25° and 30°C and relative humidity between 75 per cent and 90 per cent have been particularly found to be very much congenial for the multiplication of the insect.

The average complete life cycle of the insect is completed in 38.64 days at 30°C against 52.22 days at 25°C. This lesser developmental period at 30°C, therefore, suggests that there will be greater population increase at 30°C than at 25°C. At 30°C, population is least affected by humidity since humidity of 75 per cent and above is equally favourable for more egg laying at 30°C and 25°C. Under

TABLE 1

INFLUENCE OF DIFFERENT TEMPERATURES AND RELATIVE HUMIDITY LEVELS AND THEIR INTERACTIONS ON ADULT LONGEVITY OF *Corcyra cephalonica* (STAINTON)

Per cent relative humidity	Temperature (°C)					Average
	15°C (T_1)	20°C (T_2)	25°C (T_3)	30°C (T_4)	35°C (T_5)	
30 (RH_1)	9.50	5.22	4.32	3.16	2.18	4.88
45 (RH_2)	10.48	6.60	4.85	3.71	3.36	5.80
60 (RH_3)	10.65	7.32	5.30	4.25	2.86	6.07
75 (RH_4)	10.77	9.17	5.49	5.17	3.00	6.72
90 (RH_5)	18.32	11.66	6.50	6.33	4.14	9.33
Average	11.94	7.89	5.29	4.52	3.11	

S. Em. (T) ± = 0.04 C.D. at 5% = 0.1139
S. Em. (H) ± = 0.04 C.D. at 5% = 0.1139
S. Em (Int) ± = 0.089 C.D. at 5% = 0.2533

TABLE 2

INFLUENCE OF DIFFERENT TEMPERATURES AND RELATIVE HUMIDITY LEVELS AND THEIR INTERACTIONS ON OVIPOSITION PERIOD OF *Corcyra cephalonica* (STAINTON)

Relative humidity	Temperature (°C)					Average
	15°C (T_1)	20°C (T_2)	25°C (T_3)	30°C (T_4)	35°C (T_5)	
30 (RH_1)	2.323	3.306	2.637	2.450	2.290	2.402
45 (HR_2)	4.000	2.456	3.200	3.273	2.000	2.986
60 (RH_3)	4.190	3.663	3.310	3.000	2.000	3.233
70 (RH_4)	5.603	4.527	4.000	3.000	2.000	3.958
90 (RH_5)	7.300	7.067	5.290	4.860	2.000	5.305
Average	4.684	4.004	4.687	3.449	2.058	

S. Em (H) ± = 0.0230 C.D. at 5% = 0.0657
S. Em (T) ± = 0.0230 C.D. at 5% = 0.0657
S. Em (Int) ± = 0.0516 C.D. at 5% = 0.1468

TABLE 3

INFLUENCE OF DIFFERENT TEMPERATURES AND RELATIVE HUMIDITY LEVELS AND THEIR INTERACTIONS ON FECUNDITY OF *Corcyra cephalonica* (STAINTON)

Relative humidity percentage	Temperature (°C)					Average
	15°C (T_1)	20°C (T_2)	25°C (T_3)	30°C (T_4)	35°C (T_5)	
30 (RH_1)	190.106	217.666	183.333	183.000	157.000	188.288
45 (RH_2)	205.460	241.666	234.887	218.000	162.334	210.469
60 (RH_3)	210.000	226.000	260.667	149.667	171.667	223.000
75 (RH_4)	228.334	226.667	268.000	346.334	164.334	254.733
90 (RH_5)	228.334	338.000	338.334	339.667	322.667	313.413
Average	212.447	256.000	257.057	267.400	195.600	

S. Em (H) $\pm$ = 3.514 C.D. at 5% = 10.00

S. Em (T) $\pm$ = 3.514 C.D. at 5% = 10.00

S. Em (Int) $\pm$ = 7.857 C.D. at 5% = 22.363

TABLE 4

AVERAGE DURATION OF DIFFERENT STAGES AND LIFE CYCLE (IN DAYS) OF *Corcyra cephalonica* (STAINTON) AT DIFFERENT TEMPERATURE

Temperature (°C)	Egg	Larva	Pupa	Adult	Full life period
15	11.227	66.379	30.495	11.947	120.048
20	6.008	56.564	12.862	7.998	83.432
25	4.193	34.744	8.988	4.297	53.222
30	3.046	24.464	6.605	4.526	38.641
35	2.324	24.638	5.502	3.113	35.577

30-45 per cent relative humidity, the number of eggs laid are slightly less when compared with the fecundity at 30°C. But quicker development is observed at 30°C which leads to better population build-up even under low humidity conditions.

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27. LIFE HISTORY OF *CHALCIOPE HYPPASIA* (CRAM.), A BEAN DEFOLIATOR (NOCTUIDAE)

(*With eleven text-figures*)

INTRODUCTION

The yellow semilooper caterpillars of *Chalciope hyppasia* (Cram.) feed on leguminous crops, namely moong, ured, soybean, groundnut, mothbean, lentil, gram, pigeon pea, cowpea and sem. This moth is often extremely abundant on long grasses and is found almost round the year. Beeson (1941) and Pruthi (1969) reported the species as a pest of the forest tree *Sterculia villosa* in north of India. Presently, the insect has assumed the status of a regular pest of sem (*Hyacinth* bean) and cowpea (*Vigna sinensis*) causing defoliation of the respective crops from July to late September in western Uttar Pradesh. Considering the importance of *C. hyppasia* to various legumes, the present study on life history has been carried out.

MATERIALS AND METHODS

A laboratory culture of *C. hyppasia* was maintained on bean leaves from field collected caterpillars during July to September 1985. A regular record of number of eggs laid, larval instars, prepupal and pupal periods, adult longevity and mortality was made. Fifteen caterpillars from each instar preserved in KAAD were used for morphometrics. The average maximum and minimum temperatures and relative humidity were respectively 29.36 ± 0.170, 27.67 ± 0.20°C and 77.77 ± 0.95% during the experiment.

LIFE HISTORY

C. hyppasia (Cram.) completes its life cycle egg to adult in 33.18 ± 0.57 days during July to September under laboratory conditions with an incubation period of 4.38 ± 0.07 days, the neonate caterpillars moulted five times in a duration of 15.30 days to have six instars. The first and sixth instars larvae have an average life of 3 and 4.30 ± 1.18 days respectively whereas the rest of the caterpillars (second to fifth) have a duration of 2 days each. The pupal period has been 6.87 ± 0.33 days and adult longevity has been of similar duration.

EGGS: Eggs are laid singly on leaves in the fields and on muslin cloth in laboratory. A female lays about 61 eggs during her life. Each egg measures 0.628 ± 0.33 mm in diameter, greenish in colour, turns blackish before hatching. It is spherical in shape with smooth texture of the chorion. The micropylar end is slightly depressed and lies glued with the lower surface of the leaf at vegetal end. During July to September the incubation

period of egg chorion with the help of occipital region and hatches out with an hatchability of 96.72%.

CATERPILLARS: The newly hatched semi-loopers are brownish in general body appearance with dark brown head region, possessing 3 pairs of thoracic legs, and 3 pairs of abdominal prolegs of which two pairs articulating laterally on either side of Ab V and Ab VI and third pair on **Ab X**.

The first instar larva measured 5.40±0.29 mm in length and 0.27±0.024 mm in width with head width 0.268±0.003 mm. On the second day the caterpillar changes from brown to greenish in colour with 3.39% mortality. It feeds on soft chlorophyllus portions of tender leaves making a round hole.

The second instar caterpillar is brownish and measured 9.60± 0.291 mm in length and 0.71±0.296 mm in width. The larval head is yellowish brown in colour having width 0.514±0.0094 mm without any mortality.

The third instar caterpillar is whitish brown in colour and has yellowish prothoracic shield and dark yellow head. It measured 15.00± 0.49 mm in length and 1.10±0.040 mm in width with 0.950±0.027 mm head width. There is hardly any mortality record at this stage.

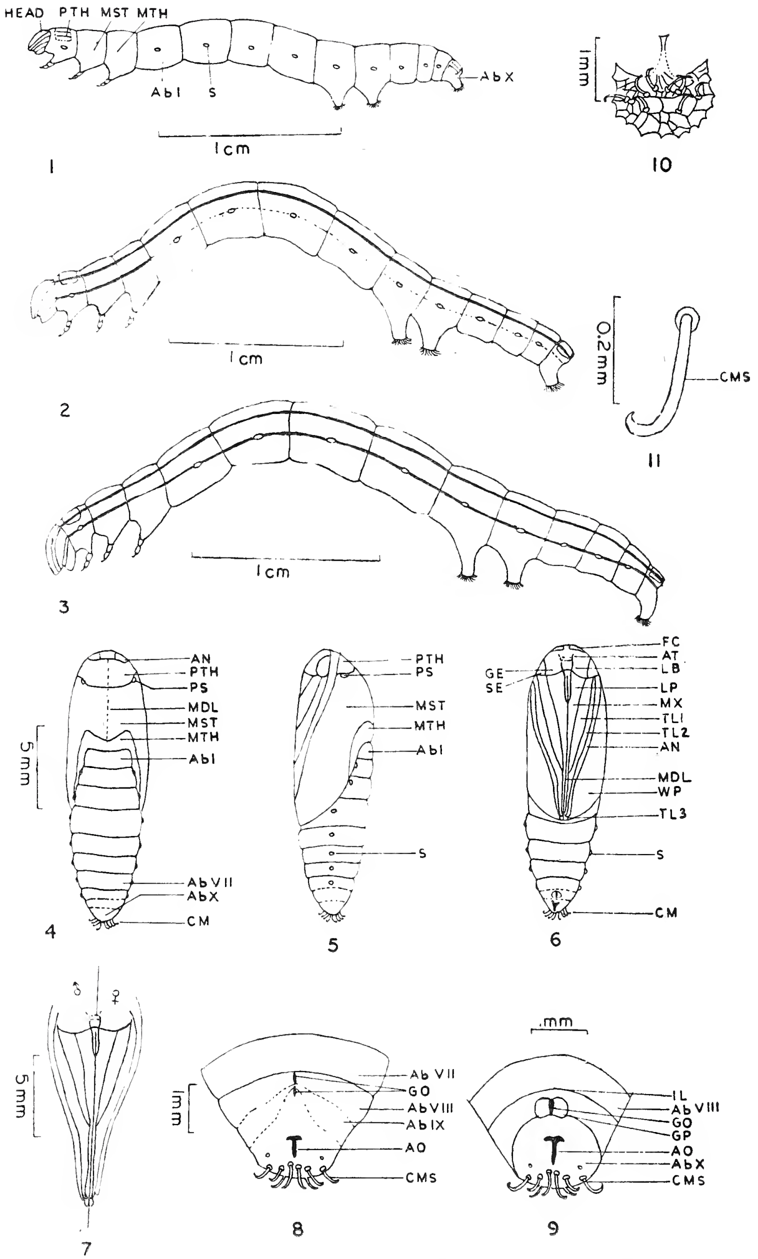
The fourth instar caterpillar is characterised by four blackish stripes on head capsule and prothoracic shield (Fig. 1). It fed freely on leaves excepting the midrib. It measured 23.60±0.66 mm in length and 2.08±0.044 mm in width having a head width of 1.40± 0.28 mm and without any mortality record.

The fifth instar caterpillar is yellowish brown in appearance characterised by having two prominent dark longitudinal stripes extending from head to Ab X mid-dorsally and one prominent stripe extending from head only upto the Th III laterally on either side (Fig. 2). The caterpillars of this stage measured 30.20±0.66 mm in length, 2.86±0.056 mm in width with head width 1.79±0.030 mm having a mortality rate of 1.75%.

The sixth instar is a long, cylindrical and smooth full grown larva. It is greenish yellow in colour having two pairs of dark longitudinal stripes running from head to the Ab X, two in the median dorsal position whereas one each on the lateral sides (Fig. 3). The semilooper also possessed two pairs of prolegs on Ab V and Ab VI and one pair of anal prolegs on Ab X. It consumed the entire leaf randomly and measured 49.80±0.66 mm in length, 3.70±0.25 mm in width having a head width 2.467±0.033 mm with 1.79% mortality rate.

PRE-PUPA: The last instar larva stops feedding and enters the pre-pupal stage enclosed by the cocoon.

PUPA: The pupa of *C. hyppasia* (Cram.) is of obtect, adecticous type and spindle shaped. The newly formed light brown pupa turns darker later and the head, three segmented thorax (PTH, MST & MTH) and ten segmented abdomen (Ab I to Ab X) are distinct. The prothorax is marked with prothoracic spiracles (PS) (Fig. 4). The fronto-clypeal (FC) sclerite is well developed and characterised by the presence of a pair of anterior tentorial pits (AT) (Fig. 6). The vertex is absent. In either side of fronto-clypeus, each eye is marked into reddish brown sculptured eye piece (SE) different from the glazed eye piece (GE). Proximally the fronto-clypeus is heavily sclerotized to differentiate into a labrum (LB.) The paired labial palpi (LP) are bifid proximally whereas entire basally and reach up to the 1/3 of the maxillae (MX). The maxillae enclosing the labial palpi run along the mid-ventral line of the junction (MVL) up to Ab IV. The prothoracic leg (TL_1) is distinct into triangular sclerite and is 2/3 of the maxilla



Figs. 1-11. Larva and pupa of *Chalciope hyppasia* (Cram.)
1. Fourth instar stage showing the starting of longitudinal stripes; 2. Fifth instar stage showing the complete middorsal longitudinal stripes and lateral stripes upto Th III; 3. Sixth instar stage showing complete mid and lateral stripes from head to Ab X; 4. Pupa in dorsal view; 5. Pupa in lateral view; 6. Ventral view of male pupa; 7. Ventral view showing the sex differentiation through antennal elevation; 8. Posteroventral end of female pupa; 9. Posteroventral end of male pupa; 10. Posterior view of caudal end showing the arrangement of cremastral setae; 11. Cremastral seta (enlarged).

whereas the mesothoracic leg (TL_2) is slightly longer than the maxilla in both the sexes. The metathoracic legs (TL_3) are partly visible caudad to the maxillae on Ab IV midventrally. A pair of antennae (AN) along with (TL_2) marks the margin of the wing pad. The antennae are slightly larger than (TL_2) in male while shorter in female (Fig. 4). Mesothorax is larger than pro-and metathorax. Prothorax and mesothorax are characterised by a middorsal line of junction (MDL) (Fig. 4). The metathorax sunken between mesotho rax and abdomen laterally extends into the metathoracic wing pad (MWP) reaching Ab IV. The abdomen has paired spiracles (S) from Ab II to Ab VIII. The abdominal segments VIII, IX and X are coupled into a single unit and is the main site of sexing the pupae. The genital opening (GO) on Ab IX lies between two genital pads (GP) in the male (Fig. 9) whereas the female has two genital openings the bursa copulatrix (BC) and ovipositional opening (OO) (Fig. 8). The bursa copulatrix lies on Ab VIII whereas ovipositional opening lies on Ab IX ventromeson in female. The intersegmental lines (TL) between Ab VIII/IX and IX/X are continuous in male but are stretched towards Ab VIII alongwith the ovipositional opening in female. The anal opening (AO) remained bifurcated anteriorly on Ab X in both the sexes. On either side of anal opening there are two punctures in both male and female. Ab X is further characterised by having four pairs of stout cremastral setae, two pairs on either side of MVL and borne on somewhat bulged and sculptured sclerite of the cremaster with prominent stalked bases (Fig. 10). Each cremastral seta is hooked and pointed distally (Fig. 11). The cremastral setae are arranged in three rows, two anterior, four middle and two posterior.

ADULT: The adult or imago emerges out of the pupa leaving the exuvia and meconium. It rests for about two hours and starts fluttering as soon as wings get dry. The male and female moths are almost equal in size and measured 35 mm across the wings. The centrally placed triangular blackish scaly area interrupted with whitish elongated stripe marks the recognizable feature of the forewing. Hindwings are characterized by a faint dull brown coloured broad stripe along the distal margin. The female moth is darker in colour than male. The sex ratio were 1:1.17 for male and female moths respectively.

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28. STUDIES ON THE BIOLOGY OF *ASPIDOMORPHA MILIARIS* F. (CASSIDIDAE: COLEOPTERA) ON THREE SPECIES OF *IPOMOEA* AND LEAF AREA CONSUMPTION STUDIES ON *IPOMOEA ANGULATA* LAMK.

Introduction

Aspidomorpha miliaris F. is an important pest of sweet potato. Both adults and grubs feed on the leaves. David and Muthaiah (1960) and Reddy and Puttaswamy (1981) recorded this species on a number of species of *Ipomoea.* Baltzar (1974) reported its biology from Philippines and Gubbaih and Devaiah (1978) have studied the biology of *A. sanctacrucia* on *Ipomoea* sp. The biology of this insect on three different species of *Ipomoea* and the leaf area consumed by the different instars and adults on *I. angulata* were studied in the laboratory at Agricultural College, Dharwad, Karnataka.

Material and Methods

Pupae of *Aspidomorpha miliaris* F. were collected from the field during July 1984 and were kept in 8″ petri dishes for adult emergence. After adult emergence five pairs of male and females were kept in five different 8″ petri dishes for observations on mating, pre-oviposition and oviposition. The mated pairs were used for egg laying. The first batch of eggs (ootheca) laid by the mated pairs collected from *Ipomoea angulata* were kept separately in a 4″ petri dish until hatching. On hatching the first instar grubs were transferred singly to petridishes containing fresh leaves of *Ipomoea angulata, Ipomoea palmata* Hort. and *Ipomoea batata* L. The experiment was conducted during July and August 1985 and replicated three times for biological studies and five times for leaf area consumption studies. Leaves of the food plants were renewed daily. Observations on different instars of grubs, prepupal stage, pupal stage and adult stage were recorded daily. After emergence, mating period, pre-oviposition, and ovipositional period, number of ootheca laid by each female, post-oviposition period and fecundity were recorded. In case of leaf area consumption studies, area consumed by each instar grubs and adults were recorded by using planimeter. The male and female were identified during pupal stage. As grubs were reared singly, based on pupal stage identification, male and female leaf area consumption have been differentiated in grub stage itself.

Results and discussion

I. *Observation on field collected Beetles*

Five pairs of male and female beetles were kept separately in 8″ petri dishes containing *Ipomoea angulata* leaves after emergence from field collected pupae. Duration of the mating was found to be quite variable (13 min. to 48 min.). Mating and oviposition periods overlapped in a particular case (The male continued to mate with the female during the oviposition period also). The highest number of matings observed in a pair was six. Mating period occupied an average of 2.20 days (Table 1). At the beginning of mating the male mounts the back of the female and starts violent lateral shakings of the abdomen. The female during copulation was often observed to expand the elytra slightly from time to time. Pre-oviposition, ovi-position and post ovi-position periods of female were found to be 1.25 days, 2.60 days and 7.60 days respectively. Average number of batches (ootheca) laid by a female was 2.60 with an

TABLE 1

DATA ON MATING AND OVIPOSITION OF FIELD COLLECTED ADULTS OF *A. miliaris*

	Observations	Minimum	Maximum	Average
1.	Mating period (days)	1	4	2.20*
2.	Pre-oviposition period (days)	1	2	1.25
3.	Oviposition period (days)	2	5	2.60
4.	Number of ootheca laid (number)	2	6	2.60
5.	Post-oviposition period ((days)	4	10	7.60
6.	Fecundity (number of eggs)	124	219	171.50

* Average of 5 copulating pairs.

average fecundity of 171.50 eggs (Table 1).

II. *Observations on laboratory bred Beetles*

Grubs: The grub is carabiform with well developed, pigmented and dark brown coloured head. Mouth parts hypognathus, colour yellow except in the 1st instar, in which the colour is creamy white. Head partially concealed by the prothorax; Three pairs of 4 segmented thoracic legs with one claw present; circular spiracles present dorsolaterally (one pair on prothorax and 7 pairs on abdominal segments 1 to 7); 8th abdominal segment possesses a pair of curved, stiff non-segmented spines projecting dorsally; lateral aspects of thorax and abdomen with transperant filaments (1st instars) or multisetiferous scoli (II, III, IV and V instars); black spots present on dorsal surface of thorax and abdomen in all instars except 1st instar.

First Instar: The first instar grub after hatching emerges through the lower portion of the ootheca by biting minute holes. Creamy white in colour and without any spots on its body.

Lateral aspects of thorax and abdomen bears 20 transparent filaments. Grubs after hatching, wander about on the leaf surface for some time and then settle on the lower leaf surface and feed by scraping the chlorophyllous tissue from the lower epidermis. In the mass culture they were gregarious and fed in groups with the head towards the centre of the group. The first instar grub carries a palate of excreta on the stiff pair of spines on the 8th abdominal segment. The grub when teased twist the tip of the abdomen upwards and lower the spines with the excreta they carry. In all the three species of *Ipomoea* the duration of the first instar was found to be 2 days (Table 2). The first instar grub measured about 1.007 mm in length 0.434 mm in breadth.

Second Instar: After the first moult, the second instar grub carries the exuvium at the tip of the stiff pair of spines on the 8th abdominal segment. Colour of the second instar grub is yellow. Tiny black spots appear on the dorsal surface, thorax and abdomen. Number of spots on different segments are as follows. Prothorax-2 spots; mesothorax-4 big spots in first transverse row; abdomen with 5 spots on each of the segments from 1 to 7, arranged in five longitudinal rows (spots on the median line are very minute). Thirty two scoli with transparent spines occur on the lateral aspects of thorax and abdomen. In the second instar the stiff pair of caudal spine was more prominent with black tip and white base. Spiracles were pale white and circular. The grubs feed by scraping in the early part of second instar but late second instar grubs were also gregarious. Duration of the second instar was less (3.33 days) in *Ipomoea batata* in comparison to the other two species of *Ipomoea* (Table 2). The second instar grub measured 4.083 mm in length and 2.16 mm in breadth.

TABLE 2

LIFE HISTORY OF *A. milliaris* ON THREE SPECIES OF *Ipomoea* IN LABORATORY

	Ipomoea angulata			*Ipomoea palmata*			*Ipomoea batata*		
	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
Incubation period (days)	6	6	6.00	6	6	6.00	6	6	6
Larvae (days)									
I Instar	2	2	2.00	2	2	2.00	2	2	2
II Instar	4	5	4.33	4	5	4.33	3	4	3.33
III Instar	3	4	3.67	2	3	2.67	2	4	2.67
IV Instar	4	5	4.67	5	6	5.33	4	5	4.67
V Instar	5	7	6.33	7	7	8.00	6	7	6.33
Pre-pupal period (days)	2	2	2.00	1	2	1.33	1	1	1.00
Pupal period (days)	6	7	6.33	6	8	7.00	5	6	5.67
Adult longevity (days)									
Male	22	26	24.33	30	33	32.33	23	25	23.33
Female	30	34	31.66	36	39	38.67	28	31	29.66
Fecundity (number)	24	62	43.00	30	58	44.00	32	72	52.00

Third Instar: The third instar grub retained the exuvium of the first moult. The black spots became more conspicuous. Numbers of scoli were same as in the previous instar. During the early part of the instar the grub fed gregariously but later on they dispersed and fed singly by biting holes in the leaf. The grub had 12 black spots on the ventral surface of the abdomen. They fed voraciously on all the three species of *Ipomoea*. The third instar grub measured about 6.33 mm in length and 3.50 mm in breadth.

Fourth Instar: Exuvium of the third moult was also retained by the fourth instar grub just below the previous two exuviae. Grubs usually fed singly and voraciously. Armature and body coloration were same as in case of the third instar. The fourth instar grub measured about 10.58 mm in length and 5.41 mm in breadth.

Fifth Instar: Fifth instar grub retained the exuvium of the fourth moult below the exuviae of the earlier moults. Grubs were very voracious during this stage and fed singly. In the mass culture, the grubs nibbled the petioles also. Armature and body coloration were same as that of 4th instar. The grubs shed all the exuvium but still a little exuvium sticks to the base of the stiff caudal spines (Vrogamphi). The fifth instar measured about 13.842 mm in length and 7.52 mm in breadth.

Pupa: *A. miliaris* pupates strictly on the lower surface of the leaf in field but in the laboratory they pupated on both the surfaces. Pupa firmly adheres its abdominal tip to the leaf surface. Freshly formed pupae were shining yellow in colour and without spots. Prothoracic shield was prominent and has four transparent spines on the cephalic margin. Each of the abdominal segments (1 to 5) bears laterally a pair of transparent scale like plates ending in a black spine. Black spots appear gradually on the body, with the thoracic spots appearing first and abdominal spots on pupae and varied according to their maturity. Before adult emergence, the number of spots on pupae are on prothorax-5 spots, 1st abdominal segment-4 spots (inner 2 spots bigger and

hexagonal) seventh abdominal segments-2 spots.

A part of the last exuvium may still remain on the tip of the abdomen in pupa. The stiff pair of caudal spines remains in the pupae in exarate. Pupal period on different *Ipomoea* species are presented in Table 2. Female pupae were bigger in size than male pupae with no difference in number of spots. The male and female pupae measured 10.50 mm and 11.25 mm in length and 8.00 mm and 9.12 mm in breadth respectively.

Adult: Freshly emerged adult beetles are light pinkish in colour with transparent elytra having faint spots. Gradually the spots become darker. Colour of the elytra gradually changes to yellow and then reddish yellow after about 15 days of emergence. Males were smaller than the females. Females were more or less round in shape but the males were somewhat elongate or oval in shape. Prothoracic shield completely covers the head of the adult beetle. Head hypognathus and antennae capitate with black tip. Prothoracic shield has one black spot in the middle. Two big irregular margin black spots were present on the transparent margin of each elytra. The distal tip of each elytra also possesses a square shaped black spot. Besides there were three spots on the margin, each elytra possesses 12 more spots. In general each elytra possesses 15 spots. Adults feed by biting holes on both the surfaces of leaves. The legs were yellow in colour. The adult male and female measured about 12.167 mm in length and 10.50 mm in breadth and 14.167 mm in length and 11.91 in breadth respectively. The longevity of adult male and female are presented in Table 2.

Fecundity: On all the three species of *Ipomoea* the female laid 2 ootheca. Average number of eggs laid in three different species of *Ipomoea* were 43, 44 and 52 in *I. angulata*, *I. palmata* and *I. batata* respectively.

III. Leaf area consumption studies on *Ipomoea angulata*:

The first, second, third, fourth and fifth instar grubs and adults of males on an average consumed 0.26±0.14, 0.46±0.41, 0.68±0.37, 0.66±0.49, 1.51±0.51 and 10.70±0.67 sq.

TABLE 3

LEAF AREA CONSUMED BY DIFFERENT INSTARS AND ADULTS OF *A. miliaris* ON *I. angulata*

Stages		Period in days			Leaf area consumed (sq. cm.)		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean
First Instar	Male	2	2	2±0	0.22	0.31	0.26±0.14
	Female	2	2	2±0	0.15	0.25	0.20±0.11
Second Instar	Male	2	3	2.60±0.86	0.30	0.60	0.46±0.41
	Female	2	3	2.4 ±0.86	0.20	0.50	0.36±0.43
Third Instar	Male	2	4	2.8 ±0.45	0.56	0.90	0.68±0.37
	Female	2	4	3.0 ±0.50	0.30	0.80	0.75±0.48
Fourth Instar	Male	3	6	4.8 ±1.22	0.50	0.95	0.66±0.49
	Female	3	6	4.8 ±1.22	0.35	0.91	0.57±0.45
Fifth Instar	Male	6	7	6.4 ±0.86	1.30	1.90	1.51±0.51
	Female	6	7	6.6 ±0.83	0.60	1.65	1.36±0.64
Adult	Male	20	24	22.60±1.17	10.35	11.35	10.70±0.67
	Female	22	26	24.60±1.34	8.8	10.71	10.04±0.77

cm leaf area respectively, whereas that of female consumed 0.20±0.11, 0.36±0.43, 0.75±0.48, 0.57±0.45, 1.36±0.64, 10.04±0.77 sq. cm leaf area respectively.

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29. A STUDY ON THE EFFECTS OF CERTAIN ABIOTIC FACTORS ON THE ACTIVITY OF *MYLLOCERUS LAETIVIRENS* NABL. (COLEOPTERA: CURCULIONIDAE)

INTRODUCTION

Myllocerus laetivirens is a very serious pest of trees and plants. Its ecology has not been studied so far. An attempt has been made here to find out the correlation between the yearly activity of this beetle with certain abiotic factors at Pilani (Rajasthan).

MATERIAL AND METHODS

The beetle was caught with the help of Pilani type light trap (Kundu *et al.* 1961) operated daily for two years (1976-1977) from dusk to dawn at Pilani (Pilani is on the North-eastern side of Jhunjhunu District of Shekhawati region in semi-arid zone of Rajasthan, India, Its geographic position is 28°20′N latitude and 75°35′E longitude and 330 msl.)

The dependent factor, i.e. the yearly activity of *M. laetivirens* has been correlated with the various independent abiotic factors, i.e. 8.30 A.M. relative humidity, 5.30 P.M. relative humidity, minimum temperature, maximum temperature, mean temperature and rainfall. In order to achieve this, regression analysis, partial regression analysis, multiple regression analysis and Beta coefficient analysis has been conducted.

The numbers of all the captures of *M.*

laetivirens have been converted to log values from which all mathematical calculations have been done (Williams 1937). Five day means of the log values of the capture have been used for the purpose of calculations (Chand 1979). Since the value of log of zero is minus infinity, one has been added to all catches before taking their log values (Williams 1939).

Results

The various regression equations obtained on *M. laetivirens* due to the effect of eight various abiotic factors for the period January to December [both years (1976-1977) taken together] are given below:

i) Soil moisture $Y = 0.1736X + 0.0930$: ($r = 0.7373$, $P<0.001$)

ii) 8.30 A.M. relative humidity $Y = 0.0260X - 1.4572$: ($r = 0.5575$, $P<0.001$)

iii) 5.30 P.M. relative humidity $Y = 0.0230X - 0.5700$: ($r = 0.6192$, $P<0.001$)

iv) Mean relative humidity $Y = 0.0261X - 1.0821$: ($r = 0.6109$, $P<0.001$)

v) Maximum temperature $Y = 0.0166X - 0.1181$: ($r = 0.1312$, $P<0.01$)

vi) Minimum temperature $Y = 0.0507X - 0.4274$: ($r = 0.5362$, $P<0.001$)

vii) Mean temperature $Y = 0.0427X - 0.6286$: ($r = 0.3784$, $P<0.001$)

viii) Rainfall $Y = 0.0984X + 0.2505$: ($r = 0.5479$, $P<0.001$)

The extent of increase or decrease in various climatic factors required to double the catch is as below:

Soil moisture (%)	= 1.71%
8.30 A.M. relative humidity	= 11.57%
5.30 P.M. relative humidity	= 13.08%
Mean relative humidity	= 11.53%
Maximum temperature	= 18.13°C
Minimum temperature	= 5.93°C
Mean temperature	= 7.04°C
Rainfall	= 3.05mm

The values of partial correlation coefficients of log catch on various climatic factors are given in Table 1.

Multiple regression equation derived is given below:

$$Y = 0.5547 + 0.1366X_1 + 0.0060X_2 + 0.0014X_3 - 0.0638X_4 + 0.0763X_5 - 0.0550X_6:$$
$$(r = 0.8466,\ P<0.001)$$

The Beta regression coefficient values due to the various climatic factors are:

Soil moisture (%)	= 0.5713
8.30 A.M. relative humidity (%)	= 0.1300
5.30 P.M. relative humidity (%)	= 0.0396
Maximum temperature	= –0.5038
Minimum temperature	= 0.8068
Rainfall	= –0.3066

Based upon the multiple regression analysis technique, the level of increase required in a particular parameter in order to double the catch of this beetle, keeping all other parameters constant at that time are given below:

Soil moisture (%)	= 2.20
8.30 A.M. relative humidity (%)	= 50.16
5.30 P.M. relative humidity (%)	= 215.00
Maximum temperature (°C)	= –4.71
Minimum temperature (°C)	= 3.94
Rainfall (mm)	= –5.47

Discussion

Based upon the values of simple correlation coefficients, it is evident that the highest value is obtained due to soil moisture (=0.7373)

followed by 5.30 P.M. relative humidity ($r = 0.6192$), mean relative humidity ($r = 0.6109$), 8.30 A.M. relative humidity ($r = 0.5575$); rainfall ($r = 0.5479$); minimum temperature ($r = 0.5362$), mean temperature ($r = 0.3784$) and maximum temperature ($r = 0.1312$). All, except maximum temperature, are significant at $P < 0.001$ level. Further the most influential value of regression coefficient is obtained on soil moisture (0.1736).

It is observed that the minimum level of increase required in a certain parameter in order to evoke a response in the log catch of *M. laetivirens* to double itself, is found in case of soil moisture (1.71%) followed by rainfall (3.05 mm) and minimum temperature (5.93°C). So, according to the results of simple regression analysis it seems that soil moisture, rainfall and minimum temperature are more influential in that order. Also, the relative humidity parameters exercise almost equal influence role. However, minimum temperature seems to play an insignificant role in determining the log catch of *M. laetivirens* ($r = 0.1312$, $P < 0.01$).

The salient feature of partial regression analysis is that soil moisture in fact, derives its influence indirectly from rainfall and acts most positively on the log catch (Table 1). On the contrary, rainfall itself seems to acquire a negative role individually; obviously soils get water only if rains are there.

The coefficient of multiple correlation is 0.8466 which is significant at $P < 0.001$ level, thus 75% variability in the log catch is associated for by a linear combination of soil moisture (X_1), 8.30 A.M. relative humidity X_2, 5.30 P.M. relative humidity X_3, minimum temperature X_4, maximum temperature X_5 and rainfall X_6, according to the following regression:

$$Y = 0.5547 + 0.1366X_1 + 0.0060X_2 + 0.0014X_3 - 0.6384X_4 + 0.0763X_5 - 0.0550X_6$$

TABLE 1

SHOWING THE PARTIAL AND SIMPLE REGRESSION COEFFICIENTS OF LOGCATCH FOR *M. laetivirens* CLIMATIC FACTORS FOR THE PERIOD JANUARY TO DECEMBER BOTH YEARS (1976-1977) TAKEN TOGETHER

Climated variables / Independent variables	Soil Moisture	8.30 A.M. R.H. %	5.30 P.M. R.H. %	Mean R.H. %	Maximum temp. (°C)	Minimum temp. (°C)	Mean temp. (°C)	Rainfall	Simple Regression
Soil Moisture	—	0.1480	0.1384	0.1395	0.1756	0.1486	0.1639	0.2441	0.1765
8.30 A.M. R.H. %	0.0099	—	0.0030	−0.0178	0.0333	0.0252	0.0294	0.0179	0.0260
5.30 P.M. R.H. %	0.0091	0.0209	—	0.0178	0.0253	0.0197	0.0227	0.0168	0.0230
Mean R.H. %	0.0105	0.0417	0.0061	—	0.0306	0.0234	0.0270	0.0189	0.0261
Maximum temp.	0.0142	0.0612	0.0358	0.0441	—	−0.1359	−0.2719	0.0172	0.0166
Minimum temp.	0.0256	0.0491	0.0403	0.0438	0.1357	—	0.2715	0.0374	0.0507
Mean temp.	0.0229	0.0545	0.0410	0.0466	0.2717	−0.2717	—	0.0316	0.8427
Rainfall	−0.0592	0.0659	0.0499	0.0541	0.0986	0.0742	0.0884	—	0.0984

which may be interpreted to mean that estimated log catch increases or decreases by a value equal to the net regression coefficients of the respective climatic factors as shown in the equation.

From the absolute values of Beta coefficients it is apparent that the order of relative importance of the different climatic factors is as follows:

Soil moisture (0.5713), Minimum temperature (0.8068), 8.30 A.M. relative humidity, 5.30 P.M. relative humidity, and negative values are obtained on maximum temperature (–0.5038) and rainfall (–0.3066).

From the above account it is clear that soil moisture and minimum temperature are the two most influential climatic factors in determining the log catch of *M. laetivirens*, and maximum temperature and rainfall tend to play a negative role whereas the abiotic factors considered are insignificant.

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30. DEVELOPMENTAL BEHAVIOUR OF ALATE AND APTEROUS FORMS OF *MYZUS PERSICAE* (SULZER) ON ROCKET SALAD IN PUNJAB[1]

INTRODUCTION

Myzus persicae (Sulzer) has been reported to cause injury of economic significance on rocket salad (*Eruca sativa* Linn.) in Punjab (Sandhu *e tal.* 1981). The pest is cosmopolitan in distribution (David 1957). In India it has been reported from all the states (Ghosh 1974, Verma and Misra 1975, Verma 1977). The insect is polyphagous in nature and has been reported to feed on 221 different hosts

[1] A part of the Thesis of the junior author approved for M.Sc. (Entomology) degree of Punjab Agricultural University, Ludhiana, in 1984.

(Singh 1984). On rocket salad the insect is active from the last week of November to early April, but the crop sown in the end of November harbours very high aphid population, resulting in poor yield (Singh and Singh 1985). While working on the biology of this insect at Ludhiana it was observed that both the alate and apterous forms were available in abundance during January-April on rocket salad. Since no information on the relative developmental behaviour of these forms is available, it was considered desirable to collect information on various biological parameters of these two forms. The results are presented in this paper.

Material and Methods

The developmental behaviour was studied in respect of various parameters namely nymphal duration, pre-reproductive, reproductive, post-reproductive periods, fecundity, longevity and period of generations. The observations for various biological parameters were carried out starting from last week of January to first week of April, 1983. A single mother aphid of alate or apterous form was released on 4 leaf stage plant under a glass chimney with a camel-hair brush. The food was changed as and when needed. Twenty five such plants were kept for each form. The young ones produced were removed daily from these plants retaining only the mother aphid. All the plants under study were observed daily for recording the observations.

For working out the reproductive period, all the young ones produced by a given aphid in a day were dislodged with a camel-hair brush daily. Reproduction per day was calculated by dividing the fecundity of an aphid by its reproductive period.

Results and Discussion

Observations on the various biological parameters of alate and apterous forms recorded

Table 1

Duration of different nymphal instars of alate and apterous forms

Period of observation	Form of aphid	Duration of nymphal instars (days) Ist	IInd	IIIrd	IVth	Total nymphal period (days)	Temp. (°C)	R.H. (%)
23.1.1983 to 1.4.1983	Alate	3.0	3.0	6.0	7.0	19.0	15.7	57.0
	Apterous	2.6	2.5	2.9	3.1	11.1		

Table 2

Pre-reproduction, reproductive and post-reproductive periods. fecundity and longevity of alate and apterous

Period of observation	Form of aphid	Pre-reproductive period (days)	Reproductive period (days)	Post-reproductive period (days)	Average Fecundity	Fecundity day	Adult longevity	Period of generation (days)
23.1.1983 to 1.4.1983	Alate	1.0	33.0	0.0	48.0	1.5	33.0	54.0
	Apterous	1.1	19.1	6.1	73.0	3.1	25.2	42.1

from 23.1.1983 to 1.4.1983 are discussed below.

The total nymphal duration of alate form was 19.0 days against 11.1 days of apterous form (Table 1). But there was no difference in the pre-reproductive period of this period, being 1 day in case of alate and 1.1 days in case of apterous form (Table 2).

The reproductive period of two forms also varied greatly. It was 33 days in the alate form against 19.1 days in the apterous form (Table 2). Toba (1964) reported the reproductive period of alate to vary from 1-26 days in Hawaii. However, Lal (1950) reported that the reproductive period of alate *M. persicae* varied from 10-17 days at Delhi during different months.

Data in Table 2 reveal that the post-reproductive period of alate was zero against 6.1 days in that of apterous. Average daily rate of reproduction of alate was 1.5 nymphs as compared to almost double (3.1 nymphs) in case of apterous. The average number of nymphs laid by a single alate female in its life was 48.0 and that of apterous 73.0. Lal (1950) and Toba (1964) have also reported that the number of off-springs laid by alate female are less than that of apterous. The longevity of adult alate was 33.0 days against 25.2 days in apterous form. The greater longevity of alatae than that of apterae seems to give the former more time for dispersal and transmission of plant virus diseases. The period of generation of alate form was 54.0 days against 42.1 days of apterous. Lal (1950) also observed that alate survived longer than the apterous.

From the above observations, it can be summarized that the total nymphal period, reproductive period, longevity and period of generation of alate *M. persicae* are comparatively longer than those of apterous but post-reproductive period and fecundity are less than that of apterae.

ACKNOWLEDGEMENT

We are grateful to Dr. B. S. Chahal, the then Professor-cum-Head, Department of Entomology, Punjab Agricultural University, Ludhiana for facilities and to Director, Commonwealth Institute of Entomology, London for arranging the identification.

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31. *ALPINIA MUTICA* ROXB. (ZINGIBERACEAE) — A NEW RECORD FOR PENINSULAR INDIA

(*With a text-figure*)

While investigating the Zingiberaceae of Karnataka, we came across a species of *Alpinia* growing at Central Plantation Crops Research Institute, Appangala which was originally collected from Courtallam area of Tamil Nadu. This plant appears to be restricted to the Western Ghats of Tamil Nadu and Kerala. There are two previous collections of this species at the herbaria of the Botanical Survey of India. One specimen is at CAL collected by J. J. Bourdillon from Travancore who labelled it as "*Alpinia mutica* Roxb.?", but, Fisher, while writing the account of Zingiberaceae in Gamble's FLORA OF MADRAS PRESIDENCY, annotated it as *A. allughas* (Retz.) Roscoe. Another collection at MH is of E. Vajravelu from Palghat District. These plants resemble *A. mutica* Roxb. in having small early deciduous bracteoles and in the 1 — 3-flowered cincinni but differ from it in the presence of subulate staminodes and larger leaves with pubescent lower surface. As these differences are not significant to make it a new species, these plants perhaps constitute not more than a variety of *A. mutica*. This species was described by Roxburgh from plants cultivated at Calcutta, introduced there from Penang. This species was hitherto not known from Peninsular India and was recorded only from Malaya, Borneo and Indo-China.

A brief description of the plant is given below:

Alpinia mutica Roxb. in Asiat. Res. 11: 354. 1810; Baker in Hook. f., Fl. Brit. Ind. 6: 254: 1892. *Catimbium muticum* (Roxb.) Holtt. in Gard. Bull. Sing. 13: 150, fig. 17. 1950. (Fig. 1).

A rhizomatous herb; rhizome *c.* 2.5 cm in diameter, white or pale pink within. Leafy stem robust, up to 2 m high with 9-11 leaves. Leaves with up to 3.5 cm pubescent petioles; lamina oblong-lanceolate, acuminate, up to 60 × 13 cm, glabrous above, densely pubescent below; ligule *c.* 8 mm long, pubescent, entire; sheaths pubescent. Inflorescence up to 16 cm long, erect or occasionally slightly curved, rachis pubescent, protected when young by 2 or 3 large early deciduous sheaths above the uppermost leaf. Cincinni 2—3-flowered or reduced to a single flower; stalk 0.5—1 cm long, pubescent. Bracts absent. Bracteoles rudimentary or absent at the base of the inflorescence, minute bracteoles are seen at the upper part of the inflorescence, the largest up to 6 mm long, early deciduous. Calyx *c.* 1.8 cm long, funnel-shaped, white, with 3 short hairy toothed lobes, outer surface sparsely hairy, unilaterally split. Corolla white, tube up to 1.3 cm long; dorsal lobe *c.* 2.5 × 1.8 cm, margin shortly ciliate; lateral lobes as long as the dorsal lobe but narrower, margin shortly ciliate. Labellum *c.* 3 × 3.5 cm, broadly ovate, yellow, variegated with red, the basal part concave, sides incurved, narrowing to an emarginate apex. Lateral staminodes subulate. Filament 1—1.2 cm long. Anther as long as filament, connective not produced into a crest. Ovary 5—8 mm long, pilose. Capsule globose, red, 3—3.5 × 2—2.5 cm, shortly pubescent. Seeds many, angular, 6—7 mm long, black with white aril.

Specimens examined: KERALA STATE: Travancore, 6 Oct. 1927, *J. J. Bourdillon* 115 (CAL); Palghat Dist., Melliampathy R. F., 900 m, 13 Feb. 1979, *E. Vajravelu* 60422 (MH). KARNATAKA STATE: Coorg Dist., Appangala, 8 km from Mercara, 1000 m, 30 March 1983, M. N. Venugopal (BSI & C).

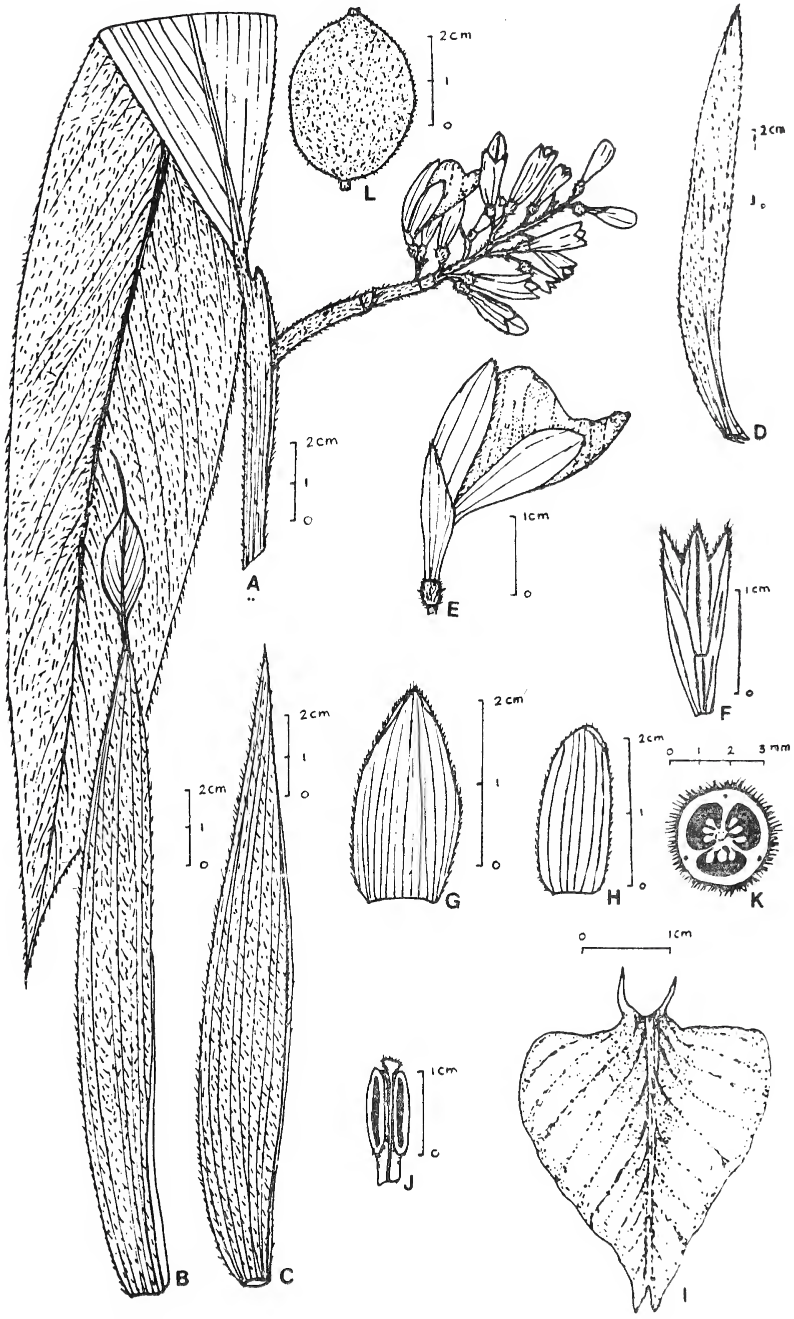

Fig. 1 (A-L): *Alpinia mutica* Roxb.
A. Flowering stem; B-D. Sheaths which surrounds the young inflorescence;E. Flower; F. Calyx; G. Dorsal lobe of corolla; H. Lateral lobe of corolla; I. Labellum; J. Stamen; K. Ovary, cross-section; L. Fruit.

ACKNOWLEDGEMENTS

Thanks are due to Miss R. M. Smith of the Royal Botanical Gardens, Edinburgh, for her valuable opinion on the identity of this species; the authorities of Botanical Survey of India for allowing the senior author to observe the Zingiberaceae sheets at their herbaria; Dr. M. A. Rau for going through the manuscript and the UGC, New Delhi, for financial assistance.

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32. *UTRICULARIA ULIGINOSA* VAHL — A NEW RECORD FOR ANDHRA PRADESH

(*With a text-figure*)

While discussing the distribution of the genus *Utricularia* in Peninsular India, Subramanyam (1981) noted that *U. uliginosa* Vahl occurs in Western ghats and in Kerala, Tamilnadu, Karnataka, Goa, Maharashtra and Madhya Pradesh. We came across this species in the valley of Erramalais, east of Ooruchintala village at about 15° 2′N and 78° 8′E in Anantapur district of Andhra Pradesh. A perusal of the herbarium specimens in different herbaria revealed that this species has also been collected from Chittoor district by G. V. Subba Rao.

As this is the first report of this species from the state of Andhra Pradesh, a detailed description along with citation and illustration of the species is given in this paper.

Utricularia uliginosa Vahl, Enum. 1: 203. 1804; Gamble 981 (689). *U. affinis* Wt. in Hook. J. Bot. Kew Gard. Misc. 1: 373. 1849; Wt. Ic. t. 1580; FBI 4: 330. (Fig. 1).

Small glabrous erect unbranched terrestrial herbs up to 15 cm tall. Leaves linear-oblong, obtuse, 1-3-nerved, traps small with basal mouth, upper lip with simple appendages. Scales linear up to 3 mm, bracts and bracteoles basifixed. Flowers bluish-purple, pedicels up to 8 mm long, erect in fruit. Calyx lobes subequal, minutely denticulate or entire, acute. Corolla bluish purple, upper lip oblong, emarginate, slightly exceeding upper calyx lobe, lower lip obovate, crenulate at apex, 6-7 mm long, palate not conspicuous, spur slightly deflexed. Capsule depressed globose, up to 6 mm long. Seeds sub-globose, 0.3 × 0.2 mm with sub-hexagonal scrobiculate areoles on the testa.

Distribution: Widely distributed along the

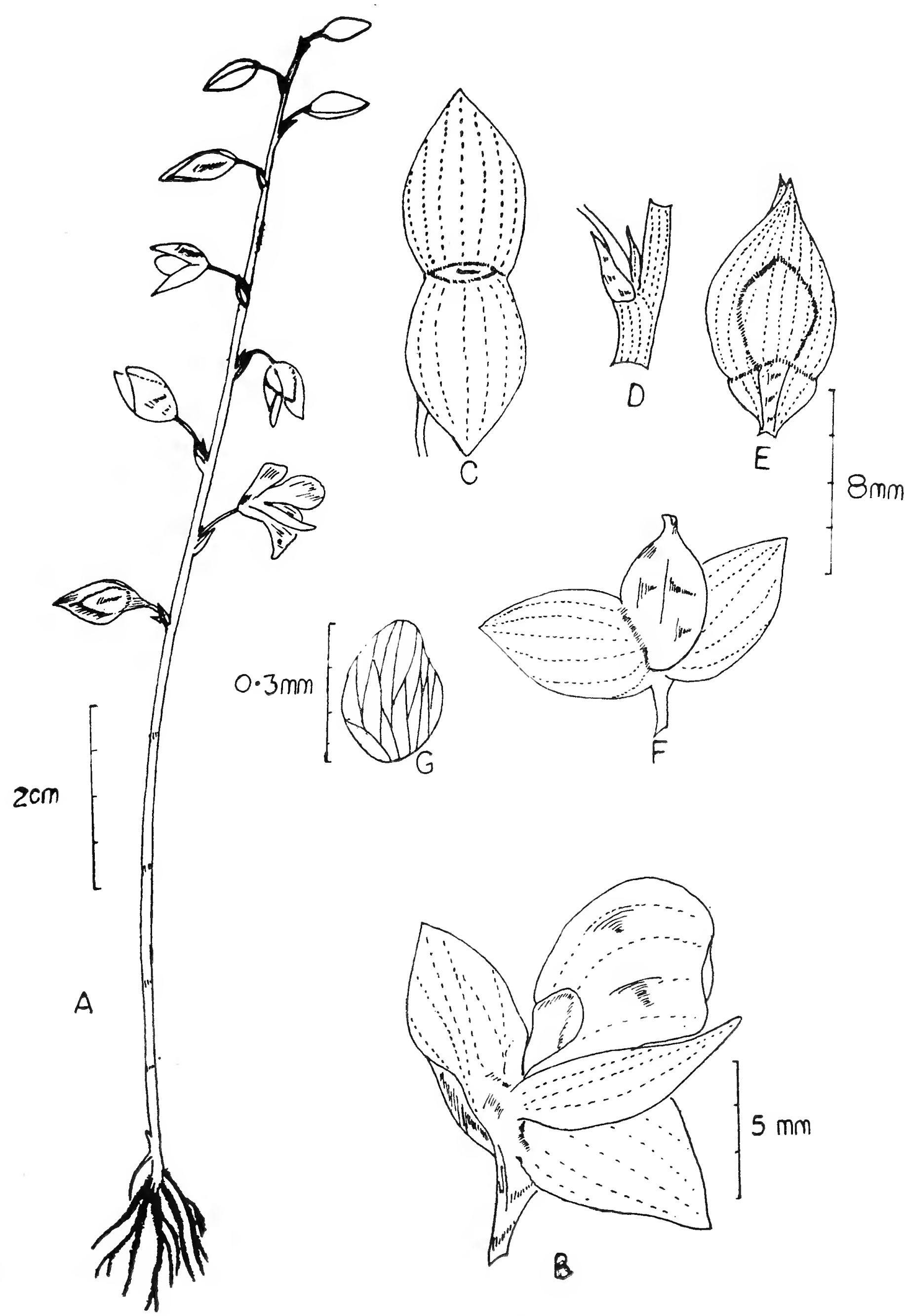

Fig. 1. *Utricularia uliginosa* Vahl
A. Habit; B. Flower; C. Calyx lobes; D. Scape with scale; E, F. Capsule with fruiting calyx (enclosed & opened respectively); G. Seed.

Western ghats and in Karnataka, Kerala, Madhya Pradesh, Maharashhtra, Tamilnadu, Goa and Andhra Pradesh (Anantapur and Chittoor districts).

Specimens examined: Garugudu kona (Anantapur district), *TP* 952 & 953 (SKU, MH); Chittoor district, *GVS Rao* 32023 (CAL, MH).

Reference

Subramanyam, K. (1981): Distribution of *Utricularia* in Peninsular India, south of Vindhyas. *Bull. Bot. Surv. India 23*: 155-164.

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33. IDENTITY OF *FLACOURTIA OCCIDENTALIS* BLATTER

Blatter (1927), in Journ. Bombay Natural History Society 31(3): 912, 1927 raised the variety of *Flacourtia ramontchi* L'Herit, namely var. *occidentalis* Hook. f. & Thoms. (Fl. Brit. India 1: 193, 1872) to the full rank of species. Variety *occidentalis* which was maintained by Cooke, Talbot and others was merged with *Flacourtia indica* (Burm. f.) Merrill, by Sleumer (Fl. Males. I, 5(1): 56, f. 30 h-i, 1959), including its type species *Flacourtia ramontchi* L. 'Herit.

Blatter has cited two herbarium specimens (i.e. E. Blatter: Khandala 18189; E. Blatter & C. McCann: Toranmal 27283), in support of justification for raising the taxon to the species rank. One of these two specimens (18189) is deposited in Blatter Herbarium (BLAT) and our examination of the specimen has revealed its identity as a spinous form of *Xantolis tomentosa* (Roxb.) Raf. (Syn. *Sideroxylon tomentosum* Roxb.). As there is no other authentic specimen of Blatter's species at Blatter Herbarium, we concluded that Blatter's name of Stat. nov. is erroneous since it is not based on the original type materials of var. *occidentalis* of Hook. f. & Thoms. However, in Cooke's description, leaves of the variety *occidentalis* are mentioned to be crenate or serrate, whereas in *Xantolis tomentosa* (Roxb.) Raf. they are entire along the margins.

All the materials belonging to the genus *Flacourtia* Commers. in Blatter Herbarium, were checked up and annotated by Dr. Sleumer and we follow him in merging the var. *occidentalis* Hook. f. with *Flacourtia indica* (Burm. f.) Merrill.

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S. M. ALMEIDA

34. TWO LITTLE KNOWN FLOWERING PLANTS FROM MAHARASHTRA

(*With a text-figure*)

1. **Cassia dimidiata** (Buch.-Ham. ex Roxb.) Collett (Fig. 1)

Roxburgh originally described *Senna dimidiata* Buch.-Ham. ex Roxb. based on plants raised in Botanical garden at Calcutta, from the seeds sent to him by Buchanan-Hamilton from Nepal.

existing literature, we confirmed its identity as *Cassia dimidiata* (Roxb.) Collett.

It resembles *Cassia mimosoides* L. very closely in having small, circular, sessile gland between or just below the lowest pair of leaflets, but differs from *Cassia mimosoides* Linn. in the following characters —

Cassia dimidiata	*Cassia mimosoides*
1. Annual, erect, stems scarcely branched.	Perennial, stems several, spreading, procumbent or ascending.
2. Peduncle 1-1.2 mm long, densely hairy with standing spreading long hairs.	Peduncle 2-2.2 mm long, with few very short appressed hairs.
3. Pedicel not easily distinguishable from the peduncle, uniformly thickened throughout.	Pedicel distinguishable from the peduncle, pedicel stouter and more hairy than the peduncle.
4. Stamens 4, all of the same size, all fertile; filament slender.	Stamens 10, alternating, long and short; filament stout.
5. Stigma very prominent, large, circular, raised, pilose at the margin.	Stigma not very prominent, not pilose at the margin, not raised.

This species is allied to *Cassia mimosoides* Linn. and it was confused with that taxon in Herbarium materials deposited in Blatter Herbarium, as well as in some of the old literature. It was merged with *Cassia mimosoides* L. as variety *dimidiata* by J. G. Baker (in FLORA OF BRITISH INDIA, Vol. 2, p. 266, 1878) and restored to specific rank in its appropriate genus *Cassia* by Henry Collett (in FLORA SIMLENSIS, p. 149, 1902). Collett's new combination has come from indirect reference to Roxburgh's *Senna dimidiata* because he cites only Baker in FLORA OF BRITISH INDIA. However, Baker's variety is based on Roxburgh's species and therefore we attribute the basionym to Roxburgh.

While going through *Cassia mimosoides* complex in Blatter Herbarium, we could isolate this taxon as a distinct material from the rest. On dissection of floral parts and studying the

We give below complete description of the species based on material available in Blatter Herbarium.

An erect, scarcely branched herb, 40-80 cm tall. Stem rounded, faintly striate, hairy. Leaves pinnate, 8-15 cm long, stipulate and glandular. Stipules 2, linear-lanceolate, 1-1.5 mm long, acuminate, terminating in an erect black spicule, 6-8 nerved from base, auricled and clinging to the stem at base, hairy. Rachis slender, 6-9 mm long, hairy all over. Common petiole short, 1-1.2 mm long, hairy; gland sessile, circular, one per leaf, just below the lowest pair of leaflets. Pinnules 20-40 pairs, opposite, sessile, oblong, 1-1.2 mm long, 0.2 mm broad, inequilateral, faintly serrate at margin, shortly mucronate at apex, 4-5 veined from base, with prominent mid vein. Flowers supra-axillary, often solitary, bracteate and pedicellate. Bracts 2-3, linear-lanceolate, 0.5-

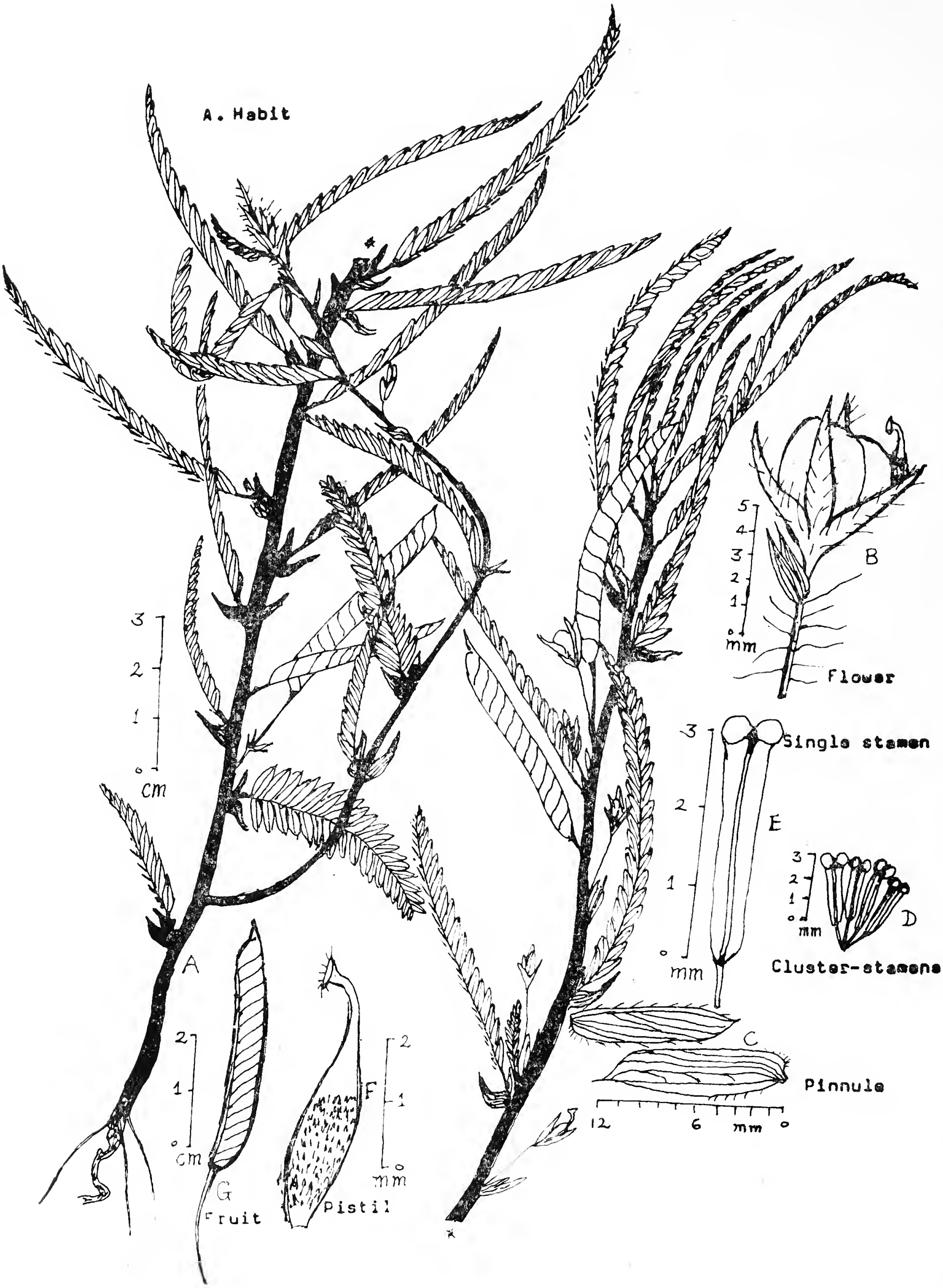

Fig. 1. *Cassia dimidiata* (Buch.-Ham. ex Roxb.) Collett
A. Habit; B. Single flower; C. Pinnule; D. Cluster of Stamens; E. Single stamen; F. Pistil; G. Fruit.

0.8 mm long, 0.1 mm broad at base, narrowing to the apex, acuminate, ending in long spicule, 4-5 veined from base, hairy. Peduncle 1-1.2 mm long, slender, hairy all over with erect spreading hairs, arises from between the centre of the 2 linear-lanceolate bracts. Pedicel 0.1 mm long, hairy, with 2 bracteoles one on each side, lanceolate, 4-5 veined, acuminate, hairy. Sepals 4, linear-lanceolate, 2 mm long, acuminate, hairy outside. Petals 4, yellow, broadly ovate, rounded at apex, 6-8 nerved, narrowing to a short claw at the base, glabrous. Stamens 4, equal, all fertile; anthers oblong, stout, about 3 mm long, opening at the apex through 2 large, circular pores; filament short, slender, glabrous. Ovary flat, linear, 4-5 mm long, 1 mm broad, velvety hairy when young, thickened and hairy at both the sutures; style stout, slightly curved, 1.5-2 mm long, glabrous; stigma large, prominent, circular, raised, pilose at the margin. Fruit brown when mature, flat, compressed, not constricted, with faint compartments, thickened and hairy at both the sutures and base, 15-16 seeded, dehiscing by the sutures.

Specimens examined:

H. Santapau — 4870, 4871, 4872, 4873, 4875 (Khandala) (10-9-1944) (BLAT).

„ — 7229 (Purandhar) (4-9-1948) (BLAT).

„ — 11400, 11533 (Purandhar) (9-10-1950) (BLAT).

Incidentally, this species has not so far been reported from Maharashtra and constitutes a new record for the state.

2. **Clitoria annua** Graham

This species was originally described by John Graham in "Catalogue of the Plants growing in Bombay and its Vicinity" (P. 47, 1839). In the original description Graham only mentioned that it is a herbaceous annual species — common on Malabar Hill during the rains. Subsequent floristic works like Bombay Flora by N. A. Dalzell and J. Gibson (1861), J. D. Hooker's FLORA OF BRITISH INDIA Vol. 2 by J. G. Baker (1876) and FLORA OF PRESIDENCY OF BOMBAY by T. Cooke (1902) do not mention the occurrence of this Plant. It is obvious that there was no specimen of this species at Kew for examination and therefore all these authors who have worked at the Kew herbarium have not included it in their respective works. However, they have included Dalzell's later described species *Clitoria biflora* Dalz. (Kew Jour. Bot. 2: 35, 1850), which has been described as "Stems suberect, angular, petioles very short, leaflets 5, flowers blue, 2-flowered, bracteoles large — In the Concan — Dalzell, Stocks.

There is only one erect herbaceous species of this genus found within the present boundaries of India and we are absolutely sure that the taxon described by John Graham (1839) and N. A. Dalzell (1861) is one and the same.

We have searched in the Malabar Hill area and located the typical specimen of herbaceous erect *Clitoria*. S. M. Almeida 5890 — (Malabar Hill), (25th July 1986), (BLAT). There are a number of herbarium specimens of this species collected earlier from the National Park, Borivli and deposited in BLAT which have been named as *Clitoria biflora* Dalz. (Herbert 2224-5, Tavakari — 1571-2).

We feel that John Graham's binomial and diagnostic description of the taxon are sufficient for the identification of the species.

According to Article No. 32.2 of ICBN, Dalzell's *Clitoria biflora* should be a synonym.

For complete description of the species see T. Cooke FLORA OF PRESIDENCY OF BOMBAY (Vol. 1: 406, 1958).

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35. A NEW VARIETY OF *RUNGIA LATIOR* NEES (ACANTHACEAE) FROM SOUTH INDIA

(*With two text-figures*)

Critical studies on *Rungia latior* Nees — complex conducted both in the field and herbaria revealed that two varieties could be recognised in South India. Though there exists variation in flower size and width of the hyaline margin round the bracts in this species, the specimens collected from Anamalai hill ranges of Western Ghats do not fit within the circumscription of the typical *Rungia latior* Nees. Hence they are accommodated in a new variety. A key to the varieties, and illustrations for the new variety and some distinguishing characters of typical variety have been provided for easy comparison and identification.

Rungia latior Nees in DC. Prodr. 11: 472. 1847.

KEY TO THE VARIETIES OCCURRING IN SOUTH INDIA

Floral bracts 4.5-6 × 3-4 mm, orbicular-obovate, rounded at apex, ciliate only along the margins; bracteoles ± 5 × 3.5 mm, oblong-obovate, emarginate, obcordate or truncate at apex. (Fig. 2a-b) .... var. *latior*

Floral bracts 8-9 × 2-3 mm, oblanceolate, acute at apex, ciliate without and along the margins; bracteoles ± 7 × 3 mm, elliptic-oblong, acute at apex .... var. *anamalayana*

Rungia latior Nees var. **anamalayana** Chandrabose & Chandrasekaran, var. nov.

(Fig. 1A-J)

Rungiae latiori Nees var. *latiori* affinis sed bracteis floralibus oblanceolatis, apicibus et bracteolis ellipticis — oblongis apicibus acutis differt.

Holotypus *Chandrabose* 65859 (CAL) et isotypi (5 exsic. MH) in silva conservata Akkamalai in collis anamalayanis ditione Coimbatore in statu Tamilnaduensi die 19 Feb. 1980 lecti sunt.

Allied to *R. latior* Nees var. *latior* but differs in having floral bracts oblanceolate, acute at apex; and bracteoles elliptic-oblong, acute at apex.

Erect or ascending herbs 0.2-1 m tall, rooting at lower nodes; branchlets pubescent. Leaves 1.5-11 × 0.7-4 cm, ovate, ovate-lanceo-

late, elliptic-lanceolate or lanceolate, entire or subentire, lineolate, sparsely hispid, obtuse, subacute or shortly acuminate at apex, cuneate at base; lateral nerves 7-12 pairs, arcuate, prominently reticulate; petioles up to 2.5 cm long, pubescent. Flowers white with violet tinge, crowded in terminal or axillary spikes 2-5 cm long; peduncles 0.5-5 cm long. Barren bract 8-10 × 1-2 mm, linear-lanceolate, acuminate, sparsely hirsute without, ciliate along the margins, 3-nerved. Floral bract 8-9 × 2-3 mm, oblanceolate, acute, mucronate, hirsute without, hyaline and ciliate along the margins, 3-nerved. Bracteoles two, each ± 7×3 mm, elliptic-oblong, acute, mucronate, hirsute without along the mid-rib, hyaline and ciliate along the margins. Calyx 5-partite to the base; segments ± 6×1 mm, linear-lanceolate, acuminate, sparsely hirsute without. Corolla 1.6-1.8 cm long, 2-lipped, scattered hairy without; upper lip ± 7×6 mm, ovate, acuminate, notched or bifid at apex; lower lip ± 10×8 mm, oblong-obovate, 3-lobed, mid-lobe longer than the lateral ones; tube ± 6 mm long. Stamens 2; filaments ± 5 mm long, glabrous, attached at the mouth of corolla; anthers 2-celled, cells superposed, the lower with basal appendage. Disc cupular. Ovary 1-1.5×0.6-0.7 mm, ovoid, compressed, glabrous; style 7-8.5 mm long, filiform, glabrous; stigma notched or shortly bifid at apex. Capsules ± 5.5×3 mm, ovoid, compressed, acuminate with a short beak, shortly pubescent at the tip, 4-seeded; seeds ± 1.2 mm across, brown, suborbicular, compressed, minutely tuberculate. (Figs. 1a-j).

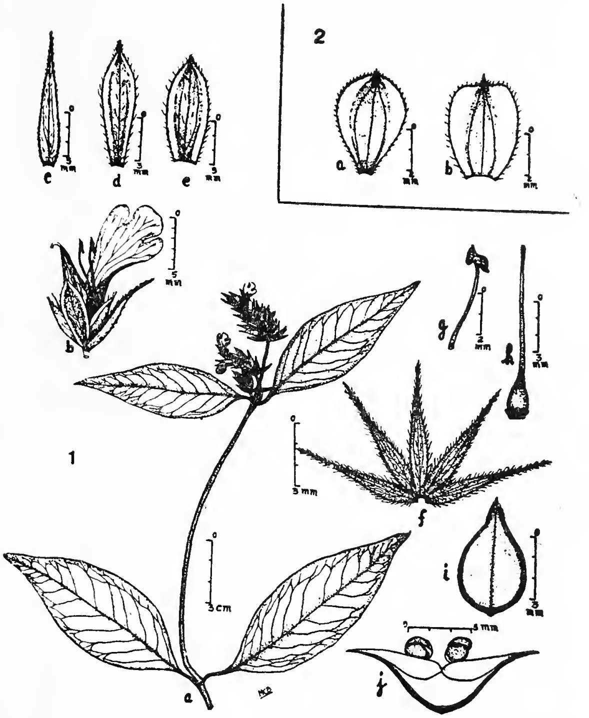

Fig. 1 (a-j): *Rungia latior* Nees var. *anamalayana* var. nov.
a. A twig; b. A flower subtended by bracts and bracteoles; c. Barren bract; d. Floral bract; e. Bracteole; f. Calyx split open; g. Stamen; h. Pistil; i. Capsule; j. Dehisced capsule.

Fig. 2 (a-b): *Rangia latior* Nees var. *latior* var. nov.
a. Floral bract; b. Bracteole.

The holotype *Chandrabose* 65859 (CAL) and isotypes *Chandrabose* 65859 (5 herbarium sheets, MH) were collected from Akkamalai R.F., Anamalai hills, Coimbatore District, Tamil Nadu on 19-2-1980.

Common along the slopes of the hills in the evergreen forests at an altitude of about 1610 m.

ACKNOWLEDGEMENTS

We are thankful to Rev. Fr. Cecil J. Saldanha, S.J., St. Joseph's College, Bangalore for rendering latin translation and to Dr. A. N. Henry, Scientist-C, Botanical Survey of India, Coimbatore for helpful suggestions.

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COIMBATORE - 641 003, INDIA.
December 3, 1986.

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V. CHANDRASEKARAN

36. *HELMINTHOSTACHYS ZEYLANICA* (L.) HOOK. (OPHIOGLOSSACEAE) — A NEW RECORD FOR WESTERN HIMALAYA

During a recent plant exploration in the Banbasa area of Kumaon Himalaya (W. Himalaya), we came across an interesting fern *Helminthostachys zeylanica* (L.) Hook. A perusal of earlier literature (Beddome 1883, Panigrahi & Dixit 1969, Dhir 1980, Bir 1983) revealed that this species was confined to the east from Bengal plains to Assam, Eastern Uttar Pradesh (Behraich and Gorakhpur), and South India only. Its range of distribution is extended to Western Himalaya, establishing a new distribution record. The specimens are lodged in the Herbarium, Department of Botany, Kumaun University Campus, Almora.

Helminthostachys zeylanica (L.) Hook. Gen. Fil. t. 47, 1840; Bedd. Handb. Ferns Brit. India 467, t. 292, 1883; Suppl. 109, 1892; and in Ferns South India 23, t. 69, 1863; Panigrahi & Dixit, Proc. nat. Inst. Sci. India 35(3): 245, 1969; Dixit, Census Indian Pterid., Fl. India Ser. 4: 20, 1984. Bas.: *Osmunda zeylanica* Linn. Sp. Pl. 1519, 1753. Syn.: *Botrychium zeylanicum* (L.) Swartz, Schrad. Journ. fur di Botanic. 111, 1800. *Helminthostachys dulcis* Kaulf. Flora 103, 1822. *H. crenata* Pr. Suppl. Tent. Pterid. 103, 1845; *H. integrifolia* pr. Suppl. Tent. Pterid. 60, 1845.

Plants green to pale yellow in colour, 15 to 35 cm high. Rhizome thick, glabrous, fleshy, creeping and bearing many thick, fleshy, glabrous, brittle roots. Stipe fleshy, glabrous, pale yellow to purplish in colour, 12 to 15 cm long. Sterile frond consisting of sessile palmatifid lamina; division of lamina oblong lanceolate in shape, acute 7-15 × 1-2.5 cm; margins entire or irregularly toothed; midrib grooved above and raised below; veins fine, once forked. Fertile segment representing a terminal and solitary spike arising from the base of the barren segment, green to brown in colour; stalk up to 7 cm long, glabrous, fleshy; spike up to 10 cm long. Sporangia borne superficially on the spike. Spores globose, dark, reticulate exine.

Fertile: August to November.

Ecological notes: Rare, in moist and shady forest floor of Sal forest and floor of Mango orchards. We could not, however, locate the specimens from the adjacent Teak and *Eucalyptus* plantations.

Specimens examined: Western Himalaya, District Nainital, near Tanakpur en route Purnagiri 700 m, P. C. Pande 18001.

Distribution: India (Western Himalaya-Khatima, Eastern Uttar Pradesh, Bengal Plains to Assam, Meghalaya and South India); Sri Lanka; Malay Peninsula; China; Japan; Philippines; Solomon Islands; New Caledonia; New Guinea; Australia.

ACKNOWLEDGEMENT

We are indebted to Dr. R. D. Dixit, B S I, Allahabad, for sending us the relevant literature.

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37. ON THE OCCURRENCE OF *LALLDHWOJIA COOPERI* FARILLE (APIACEAE) IN INDIA

(*With a text-figure*)

During plant exploration in the alpine region of Chamoli district in Uttar Pradesh, I came across an interesting plant of the Apiaceae family, which on study turned out to be a species of *Lalldhwojia* Farille. This genus was recently established and described by M. A. Ferille (1984) on the basis of its distinct fruits with dorso-lateral mericarps, superficial vittae and persistent calyx. Later, a specimen was sent to Miss J. Lamond, Royal Botanic Garden, Edinburgh, who identified it as *Lalldhwojia cooperi* Farille. The plant was first collected by R. E. Cooper on 01.03.1913 from the Sikkim-Bhutan border. No further collection of this plant had been made so far from other parts of India. The present collection from Chamoli Garhwal is an extension of its distribution to North-West Himalaya. Thus, it can be assumed that this plant is a rare endemic to the Himalayas and it is likely that its specimens may be lying with various Indian herbaria unidentified.

In the present communication, a detailed description of this plant is being given along with its original citation, habit diagram, ecology, specimens examined and distribution.

Lalldhwojia cooperi Farille, *Rev. Gen. Bot. 91*: 31-34, 1984.

Slender herbs, 15-25 cm high. Root stocks perennial, fleshy. Stems simple, glabrous and grooved. Leaves radical and cauline, sparsely pubescent. Petioles 4-6 cm long. Lamina trifoliate.Leaflets 1-2 × 1.5-2.5 cm, mucronate-dentate. Lateral petiolules 1.5 cm and terminal 1-3 cm long. Inflorescences on long axes, umbels unequal. Flowers *c.* 1-2 mm in diam., purple. Pedicels elongate in fruits. Involucral bracts absent. Sepals acute, petals obtuse. Fruits ovate elliptic, 2-3 mm in length, costae inconspicuous (Fig. 1).

My specimen (*Rawat* 2211, Herbarium WII) differs from the original description by Farille, in having larger size (15-25 cm), larger radical leaves and petioles of lateral leaflets *c.* 0.5-1.5 cm long.

Habits: Rather scarce, near shady places and rock shelters, mainly associated with *Acronema tenera, Saxifraga pallida, Parietaria debilis* etc. between elevations 3,000-3,500 m a.s.l.

Flowers and *fruits*: July-September.

Specimens examined: *Rawat* s.n. (E), *Rawat* 2211 (Herbarium W.I.I.), Tungnath, Chamoli

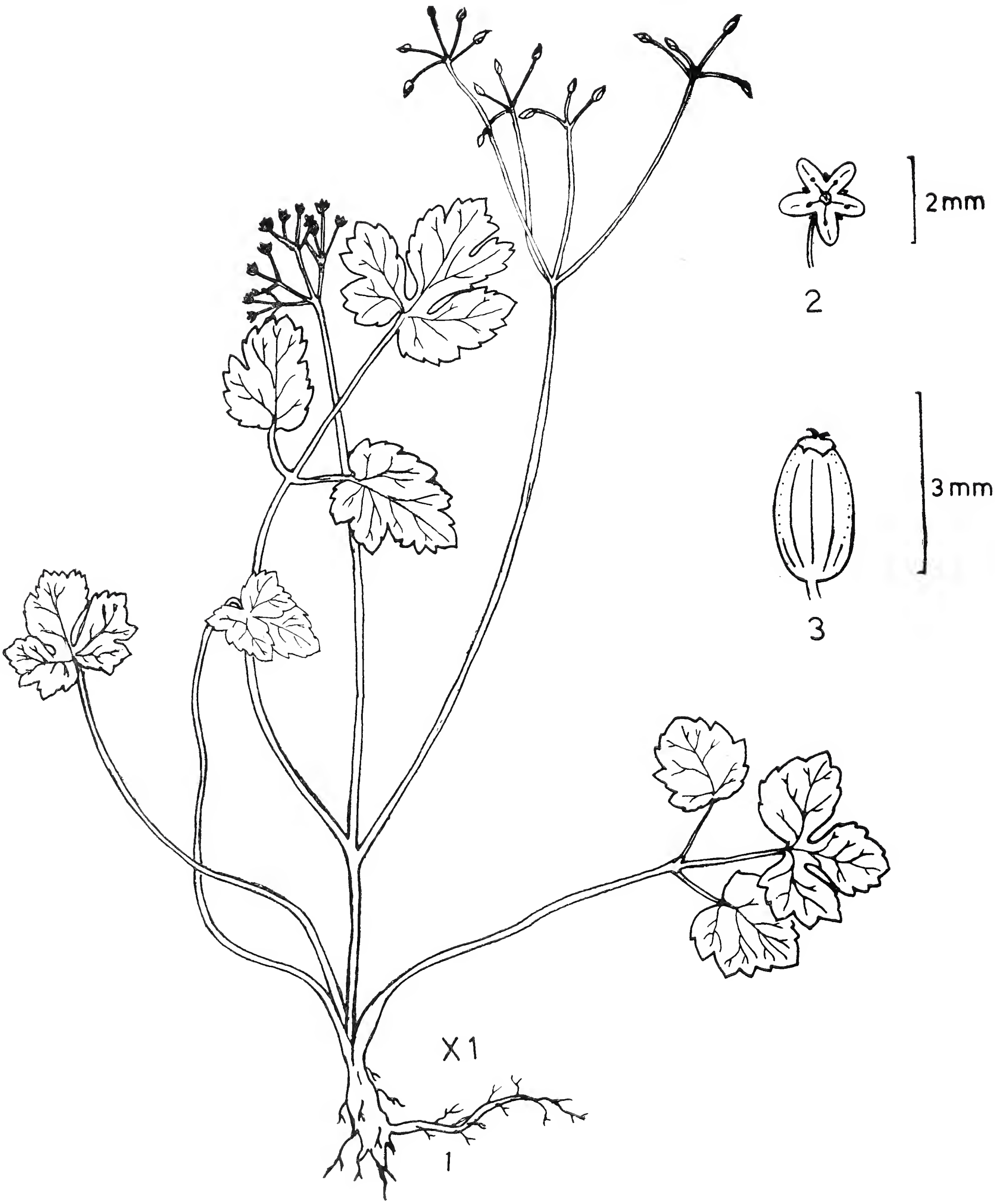
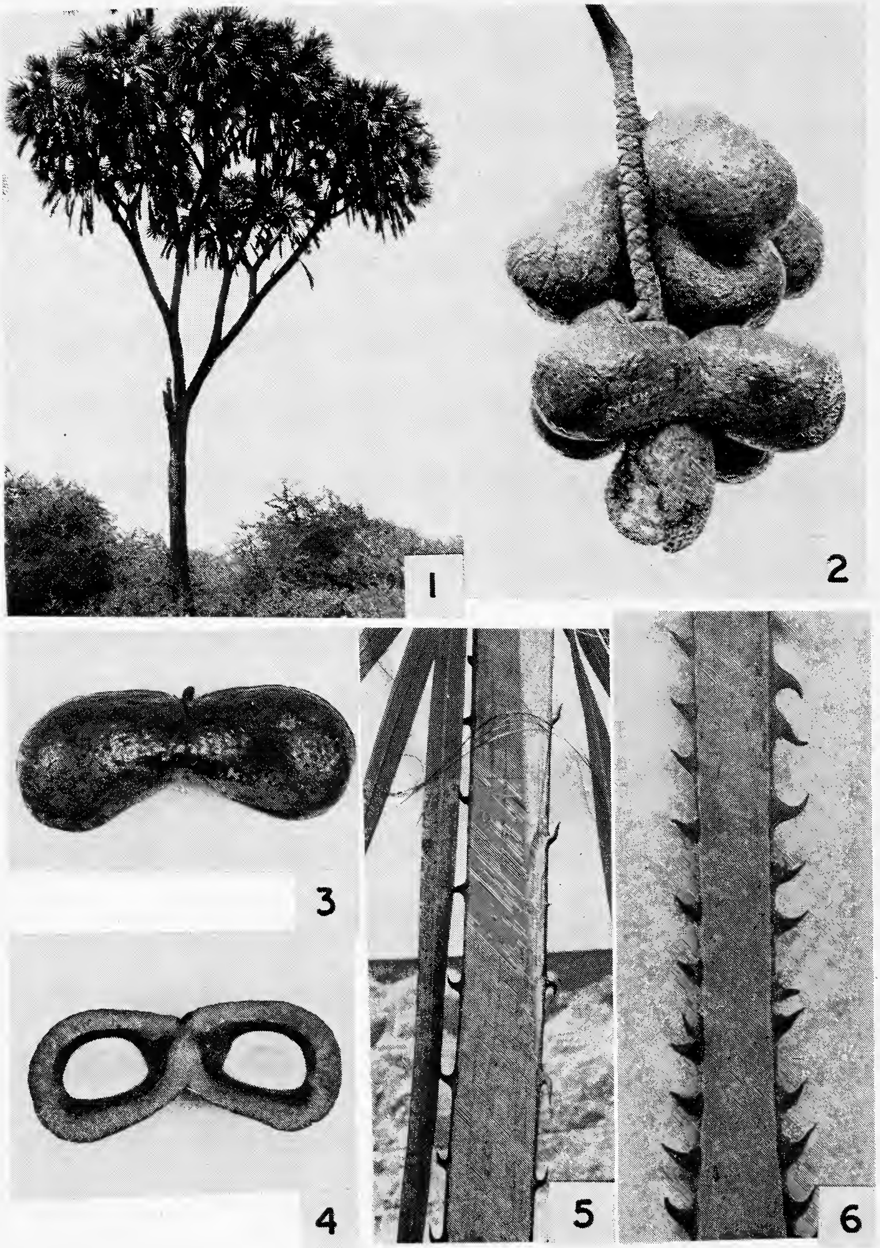


Fig. 1. *Lalldhwojia cooperi* Farille
1. Habit; 2. Flower; 3. Fruit.



1. A female plant of *Hyphaene thebaica* Mart. growing on sea coast near Nagaon. 2. A group of fruits of *H. thebaica* showing a two seeded fruit. 3. Single two seeded fruit of *H. thebaica* Mart. 4. Vertical section of the above fruit. 5. Petiole of *H. thebaica* Mart. showing spines on the edges. 6. Petiole of *H. indica* Becc. showing spines on edges.

district, Himalaya, 31.07.1986 at altitudes of 3200 and 3400 m.

Distribution: INDIA: Eastern Himalaya (Sikkim-Bhutan border), Western Himalaya (Tungnath in Chamoli district).

ACKNOWLEDGEMENT

Thanks are due to Miss J. Lamond, Royal Botanic Garden, Edinburgh for critically examining my specimens.

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December 31, 1986.

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REFERENCE

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38. IS EGYPTIAN DOUM PALM (*HYPHAENE THEBAICA* MART.) INDIGENOUS TO INDIA ?

(*With a plate*)

The Doum palm, *Hyphaene* is the most widely distributed genus of subfamily Borassoideae, having 63 species distributed in Africa, Arabia, India and islands in the Indian ocean. In India, Dalzell and Gibson (1861) were the first to record its presence in Sewree cemetery garden in Bombay. Carstensen (1891) noted its occurrence in wild state in the coastal regions at Oomrad near Surat and Mahua in Bhavnagar district. According to him, the doum palms growing in the Municipal Garden at Baroda (now Vadodara) are cultivated from the seedlings from Oomrad.

Beccari (1908) instituted the species *Hyphaene indica* on the material sent to him by Mr. G. A. Gammie from Bassein Fort in Salsette islands and from Diu. Later Burkill (1908) reported its fruit and recently Bonde (in press) described its female inflorescence and male flowers. Rao (1963, 1964) noted its luxurient growth at a number of places between 18°-23° Lat. on the west coast of India. The late Professor T. S. Mahabale (personal communication) had also noted its occurrence at Porbandar and Goa coasts. Rao also had examined the material from Municipal garden at Baroda and found *H. indica* along with *H. thebaica.*

While studying the palms of India, I noted the occurrence of Egyptian Doum palm (*Hyphaene thebaica* Mart.) on the coastal region of Nagaon (Lat. 18°37′05″; Long. 73°55′23″), Dist. Raigad, Maharashtra along with Indian Doum palm (*H. indica* Becc.) (Plate, Fig. 1). These two species differ from each other in morphology of fruits, inflorescence as noted by Rao (1963, 1964) and armature on the petiole. The spines in *H. thebaica* are tan-black coloured, pointed with broad base, the point of which is almost at right angle to its base and are distantly placed; whereas they are brown coloured, pointed with much broad base, the point of which makes acute angle with base and are closely placed in *H. indica* (Plate, Figs. 5 & 6). I also collected a number of two seeded fruits of *H. thebaica.* These are developed from the fertilization of two carpels instead of one (Plate, Figs. 2-4).

It was claimed that the Egyptian Doum palm, *Hyphaene thebaica* Mart. was indigenous to tropical Africa only. Now, that the occurrence of *H. thebaica* from Nagaon has come to notice and since its occurrence in the wild state has been known from Oomrad (Carstensen, op. cit.), this species must also be indigenous to India. Its occurrence in both Africa and India suggests that it has evolved independently in both the regions from common ancestry, existing on both the continents before they separated and it may regarded as a case of parallel evolution.

Hyphaene has a great antiquity as revealed from its fossil representatives namely, *Parapalmocaulon hyphaeneoides* (Shete and Kulkarni) Bonde, a leaf; and *Hyphaeneocarpon indicum* Bande *et al.* a fruit from the Deccan Intertrappean beds of India (Shete and Kulkarni 1980, Bonde, in press and Bande *et al.*, 1982).

The presence of both *H. indica* and *H. thebaica* intermixed with one another in the Indian Botanic Garden at Calcutta indicates that these plants might have been cultivated from the seeds obtained from west coast where both the species grow well. The extensive survey of the doum palms along the west coast from Porbandar to Goa and further south will support the indigenousness of *H. thebaica* Mart. along the west coast of India.

I thank Dr. S. H. Godbole and Dr. V. D. Vartak for facilities and encouragement.

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39. VARIETAL STATUS OF *SESBANIA SESBAN* (L.) MERR.

Sesbania sesban (L.) Merr. [Syn. *S. aegyptiaca* (Poir) Pers., *Aeschynomene sesban* L.; and *S. punctata* DC.)] is either a tall shrub or a small-tree-like growing upto 6 m high, copiously branched. Leaflets oblong, upto 3.5 cm long, but usually smaller, pods acuminate at apex, transversely divided, upto 15 cm long, glabrous, twisted, distinctly torulose (Andrews 1952). The flowers are predominantly yellow in colour. It is on the colour of vexillum alone that three different varieties have been recognized (Prain 1897, Baquar and Akhtar 1968, Bir *et al.* 1975, Sastry and Gupta 1977). The varieties include (i) var. 'sesban' — yellow vexillum, (ii) var. 'picta' — vexillum yellow with purple dots on dorsal surface and (iii) var. 'bicolor' — dorsal surface of vexillum completely dark purple/black.

During our cytogenetic studies on genus *Sesbania* an interesting observation was made in an individual plant in a population of *S. sesban* var. *'picta'*. The plant was observed to be chimeral for the colour pattern of vexillum. Some inflorescences were observed to be with yellow vexillum without any dots, typical of *S. sesban* var. *'sesban'*. The chimeral nature of the plant was evident, as different branches had either type of flowers, both types of flowers on the same branch, the same inflorescence raceme, or even the same vexillum of a single flower.

In our experimental studies the seeds of *S. sesban* var. 'picta' were exposed to different doses of gamma rays in the year 1982 to induce some translocations. However, one plant in M_1 generation was observed to show a similar chimeral pattern of vexillum colour as was observed spontaneously in nature. Besides this, two plants showed increased pigmentation as the number of purple dots was so thick that the flowers looked like those of *S. sesban* var. *'bicolor.'*

Such colour changes in flowers have been observed in Carnation (Sagawa and Mehlquist 1957), *Poinsettia* (Stewart 1960) and *Canna* (Mukherjee and Khoshoo 1970). In Carnation and *Poinsettia* such changes have been ascribed to periclinal chimeral nature of plants for colour constitution, i.e. the spontaneous/induced mutation being caused by destruction of epidermal layers and exposure of internal layers with different genetic make up. Such an explanation cannot hold true for the present case as the change, i.e. 'bicolor' ← 'picta' → 'sesban' is bidirectional. This phenomenon is similar to the one observed for the bract colour in *Bougainvillea* (Zadoo *et al.* 1975) whereby each cell contains colour constituents for both purple and yellow pigments, and there being a threshold value for each of them to express. Such a threshold value is liable to change through somatic segregation. In case of *S. sesban* there may be some cell lineages with only purple colour, others with both purple and yellow colour and still others with yellow colour only, each lineage giving rise to 'bicolor', 'picta' or 'reason' type of flowers respectively.

Keeping in view the spontaneous colour changes in the floral colour, varietal status in *S. sesban* which is based on the colour of vexillum needs to be reviewed.

ACKNOWLEDGEMENT

Thanks are due to Director, I.G.F.R.I., Jhansi for facilities.

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40. *SPIGELIA ANTHELMIA* LINN. — A NEW RECORD FOR INDIA

(*With a text-figure*)

Spigelia anthelmia L. Sp. Pl. 1(1753) 149; Fl. Malesiana 6(1962): 376-378. (Fig. 1).

Annual herb, 50-70 cm high, unbranched or with few pairs of branches arising near the base; stem erect, terete, cylindrical, green, glabrous, with a few remote pairs of small leaves and an apical pseudowhorl of four larger leaves. Leaves with interpetiolar, broadly triangular, blunt, glabrous stipules; petioles 0-0.5 cm; lamina ovate-oblong to ovate-lanceolate, 3-10 by 1-3 cm, herbaceous, scabrous above, glabrous beneath, cuneate and often decurrent at the base, attenuate at the apex; nerves 4-6 pairs, strongly ascending. Inflorescences terminal in the axils of the whorled upper leaves, up to 15 cm long, peduncle very short, glabrous; bracts lanceolate, 1.4-2 mm long. Flowers spaced, sub-sessile. Sepals 5, free, slightly unequal in length, ovate-linear-lanceolate, 2-3 mm, acute, glabrous to sparsely puberulous outside, pale green. Corolla salver-shaped, 5-lobed, glabrous, white to red or purplish; tube 6-10 mm, triangular. Stamens 5, inserted slightly below the middle of the tube, filaments filiform, 1 mm, anthers attached slightly above the base, lanceolate, 1-1.5 mm, obtuse. Ovary glabrous, subglobose, 0.5-0.75 mm, style cylindrical, 0.75 mm; stigma ovate-lanceolate, 1.5-2 mm, pubescent near the tip, caducous. Capsule 4-5 by 5-6 mm, squamulate-tuberculate. Seeds obliquely ellipsoid or ovoid, 1.5-2 mm, dull-brown, tuberculate.

Distribution: Native of South America, naturalized in tropical West Africa and in Malaysia.

Ecology: A rare weed of roadsides, waste places in forest area in sandy soils during rainy season. A self-pollinating plant; flowers open only for a very short period in the afternoon.

Ethnobotany: A poisonous plant, the decoction of the roots is said to be used as an effective vermifuge locally.

Special Note: Collected only from two localities around Jabalpur (C.O.D. and Water Works areas) during the survey of District

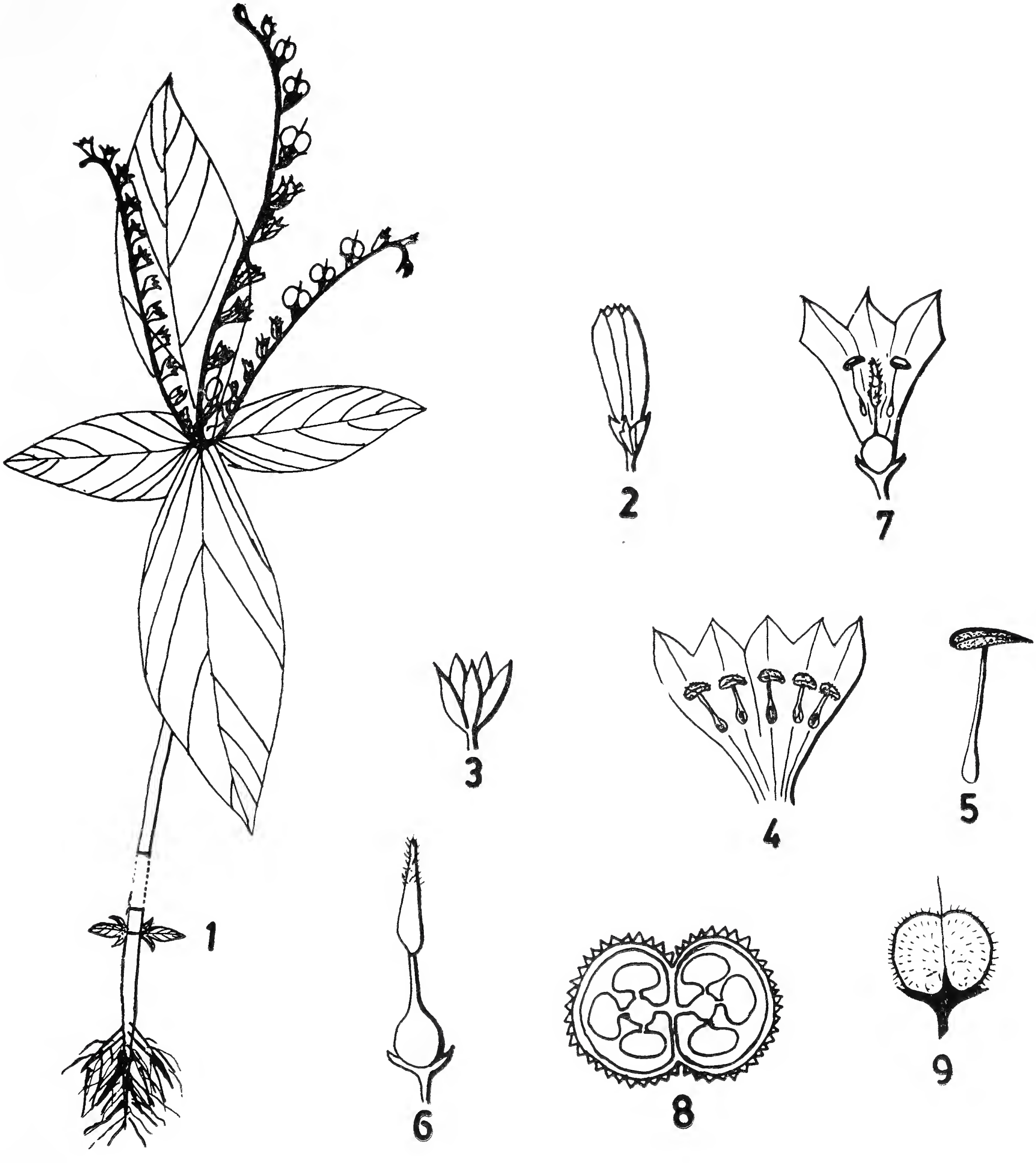

Fig. 1. *Spigelia anthelmia* L.
1. Habit; 2. Flower; 3. Calyx; 4. Corolla and Androecium; 5. Stamen; 6. Gynoecium; 7. L. S. Flower; 8. C. S. Ovary; 9. Fruit.

Flora (1983-1986). After careful study of the plant we concluded it was a Loganiaceous form but could not identify the species as we could not get similar description or drawing in the Indian Floras. Our efforts for its identification in the B.S.I. Regional Herbaria at Coimbatore, Pune, Allahabad and Dehra Dun also failed. Then it was taken to Blatter Herbarium, Bombay from where it was referred to Kew Herbarium where it was finally identified as *Spigelia anthelmia* L. of Spigeliaceae. The Keeper of Kew Herbarium at Kew confirmed that they had no material of this plant from India. Further review of available literature confirmed it as a 'New Record for India'.

Acknowledgements

Our thanks are due to Dr. G. Ll Lucas, Keeper of the Herbarium, Royal Botanic Gardens, Kew, England and also to Dr. (Mrs.) S. M. Almeida, Director, Blatter Herbarium, St. Xavier's College, Bombay for help in identification.

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1985-86

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1985

102nd Year

MEMBERSHIP

The membership data for the quinquennium 1981 to 1985 is tabulated below. You will notice that the increase per annum of the ordinary members, the mainstay of the Society, has been more or less static in the last two years. The number of new members elected to the Society in 1985 was 321 and the members who paid in 1984 but did not renew their membership in 1985 was 325!

Your committee is considering methods to make the membership of the Society appealing enough to attract more new members and retain those already on the rolls.

It is also necessary at this point to record that a marginal increase in membership fees has to be considered to meet the increase in administrative and other costs resulting from the general inflationary pressures on the Indian economy.

Patron:

We are pleased to advise members that the Prime Minister, Shri Rajiv Gandhi has agreed to be the Patron of the Society.

MEMBERS' ACTIVITIES

Field activities for members organised by the staff has been one of the main attractions of the Society over the last few decades, commencing as they did on a modest scale in 1972.

In 1985 these activities were in the form of week-end nature outings, nature walks, nature camps, meetings at the Society and support to members for their field studies on matters of natural history interest.

Day outings:

Members were taken to the Kalwa Mahim Beach on 6th January to study the littoral and beach fauna; to Karnala bird Sanctuary on 7th April and on 12th May, for bird watching; to Vajreshwari Hot springs on 19th May to study the flora and fauna; to Kharbad Hill on the Bombay-Ahmedabad highway on 26th May to Birdwatch and study plants; to Chena Creek on 23rd June for creek flora; to the Vaitarna valley on 30th June and 4th August; for birds and flora; to Meera-Dongar (Pen

	1981	1982	1983	1984	1985
Ordinary members	1044	1137	1533	1762	1764
Corporate members	176	162	158	132	152
Life members	349	407	484	562	639
Compound Corporate members	37	52	102	107	108
Student members	165	126	182	192	161
Honorary Members	3	3	3	3	3
Vice Patrons	3	4	4	6	6
	1777	1891	2466	2764	2833

Members elected in 1985, but not paid	20
Members paid for 1984, but not paid for 1985	325

taluka) on 14th July for birds and flora; to Kondgaon Lake in the Sudhagad Taluk on 8th Sept. for general flora and fauna; to Peth Kothaligad, on 6th October for deciduous forest flora and hill stream fauna; to Mulshi Lake on 13th October for deciduous forest flora and fauna.

We thank the following members and staff who either helped by leading the groups or made the arrangements:

Mr. Ulhas Rane, Dr. (Ms.) Meena Haribal, Dr. B. R. Dave, Dr. B. F. Chhapgar, Mr. Naresh Chaturvedi, Mr. P. B. Shekar, Mr. J. S. Serrao, and Mr. Vasant Naik.

Week-end Camps:

Nandur-Madhmeshwar on 2nd and 3rd February to study migratory birds. The area has been named a bird sanctuary through the active interest of the Society's members; to Bhandardara or Wilson Dam on 21 to 23rd April for general Natural History; to Matheran on 20-21 July. Matheran is particularly attractive during the monsoon months from the natural history point of view; to Suriyamal, North Thana on 27 to 28th July to study sunbirds breeding in the area; to Malshej Ghat on 24-27th August to study the peculiar phenomena of birds being swept up from the valley and either occurring in an exhausted condition in the compound of the Rest-house or killed by dashing against its wall; Mahabaleshwar on 15-18 September the late monsoon season is the best time to see the richness of the plateau's flora; Magod in North Karnataka was the venue of an extended camp from 23 to 27th November. A very rich wet tropical forest rich in bird and plant life and the study area on giant squirrels of one of our members Ms. Renee Borges.

We are grateful to our members and staff who organised these programmes, namely Mr. Ulhas Rane, Mr. Naresh Chaturvedi, Mr. P. B. Shekar, Mr. S. R. Nayak, Mr. Vasant Naik.

We would once again record our appreciation for the very generous donation of a bus by TELCO which has brought within reach areas of Natural History in the environs of Bombay and has made possible week-end camps to distant areas.

The Sanjay Gandhi National Park continued to be one of the main field activity areas of the Society where members carried out field studies in various disciplines of natural history and were trained in bird watching, plant identification, butterfly identification etc.

Lectures for members were arranged on such varied subjects as corals (Mr. Suresh Malkhani), conservation of elephants in Africa (Dr. Douglas Hamilton), wildlife of India (Mr. Robert D'Souza), Larger Cats (Dr. Paul Joslin), Natural History of Cousin Island, Seychelles (Dr. A. W. Diamond), Hydrobiological Research at Bharatpur (Dr. V. S. Vijayan), Natural History of Bhutan (Mr. Sunjoy Monga), Wonderful World of Fishes (Dr. B. F. Chhapgar), Use of Computer in Wildlife Research (Mr. Baljit Nagpal), Birds of Sahyadri (Mr. Ulhas Rane), In Search of the Bengal Florican (Mrs. Usha Bhutia), Orchids and butterflies of Sikkim (Mr. N. D. Mulla), How to be a fruit bat (Dr. T. H. Fleming), In addition 'Brains Trust' and film show programmes were also organised for Bombay members.

Members' Field Research Programmes

Bhutan Honey Guide Survey:

Mr. Sunjoy Monga studied the ecology of the Himalayan Honey Guide and generally collected data on the Avifauna of Bhutan. He spent 4 months in Bhutan. Mr. Monga was supported in the field by a grant from the Salim Ali Nature Conservation Fund.

Malabar Civet Survey:

Mr. E.R.C. Davidar organised a survey to rediscover the Malabar Civet which has not been authentically reported since 1927. Preliminary contacts were established with knowledgeable persons in the known distribution of the species by circulating an illustrated brochure. The programme was funded by the Salim Ali Nature Conservation Fund.

Flowering of Strobilanthes:

The Karvi (Strobilanthes) flowered in the Bombay environs in 1984 and the next mass flowering season will be seven years hence in 1991. Prof. P. V. Bole arranged a programme to prevent removal of the Karvi Stems before the seeds matured and assured contribution of growth of the plant in the coming years.

PUBLICATIONS

Journal:

During the year the December issue for 1984, Vol. 81 (3) and the April and August issues for 1985, Vol. 82 (1) & (2) were published. The 656 pages of these journals held 176 articles and notes. We received from members and others 360 articles and notes for publication in the journal in 1985.

After many years the journal was published on time in 1985.

SALES STATEMENT

	Sales in 1984	Sales in 1985	Complimentary copies	Balance stock 31-12-85
The Book of Indian Birds	1469	1489	4	1571
The Book of Indian Animals	692	1213	—	2278
Some Beautiful Indian Trees	225	186		1094
Glimpses of Nature India Booklet	34	81	—	—
Snake Chart	37	38	—	244 (Soiled copies)
Checklist of the Bird of Maharashtra (2nd edition)	83	92		1457
Checklist of the Birds of Delhi, Agra & Bharatpur	18	86	—	407
A Synopsis of the Birds of India and Pakistan	68	31	—	1483
Grasses of Western India	66	38		219
Some Beautiful Indian Climbers & Shrubs	162	148		2060
A Pictorial Guide to the Birds of the Indian Subcontinent	3811	2285*		3487
A Century of Natural History	269	88	3	2220
The Book of Indian Reptiles	725	460		3813

* including 2130 copies sold by OUP.

Hornbill:

The 'Hornbill' continued to maintain its popular appeal to members with articles on such varied subjects as contributed by members and staff. We continue to receive letters of encouragement and appreciation from members. The financial assistance from the Seth Purshottamdas Thakurdas Divaliba Charitable Trust has been of great assistance. We are grateful for this timely help.

No new publications were released during the year. Members will note from the sales statement given below that the BOOK OF INDIAN BIRDS continued to be the best seller among the Society's publications followed by the BOOK OF INDIAN ANIMALS.

Calendar & Greeting Cards:

The Nature Calendar for 1986 sold 12,060 copies. The Greeting Cards prepared and sold for the specific purpose of generating funds for supporting core scientific staff proved to be a successful endeavour.

Madura Coats who had prepared a folio of four reproductions from Gould's 'Birds of Asia' in the Society donated sets for sale and addition to the Society's funds. We are grateful to them for this generous help.

We are particularly grateful to M/s Larsen and Toubro Limited for the donation of 16,000 greeting cards.

Books under preparation:

ENCYCLOPEDIA OF INDIAN NATURAL HISTORY
Centenary Publication 1883-1983

Owing to various problems the Encyclopedia is still pending publication. The major portion of the work has been completed and we hope to publish this volume in January, 1987.

THE BOOK OF INDIAN TREES

The preparation of the material for this book by Prof. K. C. Sahni is in hand and photographs/transparencies of the 150 common trees in India which will be described are being collected.

CONSERVATION

The Society continues to be recognised by the Central and State Governments in India and by International Organisations abroad as an authoritative source for information on conservation of wildlife and natural resources. The recognition is expressed in the form of association of its officials with State and Central Wildlife Advisory Boards and representation on the specialist groups of the Species Survival Commission of the International Union for the Conservation of Nature and Natural resources.

UNIVERSITY DEPARTMENT

Following students submitted their thesis during 1985 which were accepted by the University.

Student	M.Sc.	Guide	Financial support
Mr. S. C. Tewari	Ecology of the Musk Shrew *Suncus murinus* with emphasis on breeding biology, Food habits, home range and territoriality.	Mr. J. C. Daniel	Nil

Student	M.Sc.	Guide	Financial support
Mr. Ranjit Manakadan	The Ecology of the Great Indian Bustard *Choriotis nigriceps.* Habitat.	Mr. J. C. Daniel	Nil
Mr. Bharat Bhusan	The Food and Feeding Behaviour of the Great Indian Bustard *Choriotis nigriceps.*	-do-	Nil
	PH.D.		
Mrs. Lalitha Vijayan	Comparative Biology of Drongos with special reference to Ecological isolation.	Dr. Salim Ali	Fellowship from Salim Ali/Loke Wan Tho Fund.
Mr. Anwar Islam	Ecology of Laughing Thrushes of India with special reference to the endemic species.	-do-	-do-

We have the following students registered forM.Sc. and Ph.D. at the Society.

	M.SC.		
Mr. Aloysius Gnanasekar	Ecology of Amphibia of Sanjay Gandhi National Park.	Mr. J. C. Daniel	Nil
Mrs. Tara Gandhi	Bird communities of exotic tree species with special reference to *Casuarina*	Dr. Salim Ali	Fellowship from Salim Ali/Loke Wan Tho Fund.
Mr. Shahid Ali	Ecology and behaviour of the Grey Partridge *Francolinus pondicerianus*	-do-	-do-
Mr. Alagar Rajan	Ecology of Spotted and Ring Doves	Dr. R. B. Grubh	Nil
Mr. Vibhu Prakash	Biology of Raptors	Dr. V. S. Vijayan	Nil
Mr. Gurmeet Singh	Ecology of Bank Myna	Dr. R. B. Grubh	Nil
	PH.D. IN FIELD ZOOLOGY		
Mr. U. Sridharan	Ecology of Resident Ducks in Keoladeo National Park	Mr. J. C. Daniel	Nil
Mr. Goutam Narayan	Birds of Prey	-do-	Nil
Mr. Manek Mistry	Contributions to the Flora of Ratnagiri District in Maharashtra.	Prof. P. V. Bole	Nil
	M.SC. IN PLANT STUDIES		
Mr. H. B. Naithani	Contribution to the Taxonomic Studies of Bamboos of North Eastern India.	Mr. M. R. Almeida	Nil

Nature Education Scheme

At the beginning of the Academic year 500 schools in Bombay and Thane were contacted through a circular letter explaining our Nature Education activities.

Approximately 5,000 students, 180 trainee teachers, and 102 principals and headmasters took part in the Nature Education activities.

The Education wing of the U.S. Fish and Wildlife Service invited the Nature Education Organiser to attend a NAEE Conference and to spend time with environmental education experts of the International Crane Foundation (Wisconsin), Tennessee Valley Association, Knoxville (Tennessee) and others to study modern methods in nature education. On her way back from the U.S., the Nature Education Organiser visited U.K. to familiarise herself with various conservation education activities undertaken by the RSPB, the Wildfowl Trust and the International Centre for conservation education.

As a part of the regular activities, 20 field trips to Borivli National Park and elsewhere namely Khandala, Karnala and Neral were organised during the year. Among these 5 were for municipal schools, 2 for trainee teachers and 4 were for Jr. Colleges. 900 students from 8th to 11th standard benefited by these field trips.

Two field trips were conducted specially for the headmasters and headmistresses at the request of the Maharashtra Department of Education. The objective of bringing Principals to study nature in the field was to make them aware of the resources available so that they would encourage their biology teachers to take advantage of these facilities.

Teaching through exhibits:

During the year 12 visits to Prince of Wales Museum, 13 visits to Victoria Garden and 7 visits to the aquarium were arranged. These visits were mainly arranged for the students of 5th to 8th standards.

Talks illustrated with Slides and Film Show:

To make students and teachers interested in the subject, talks illustrated with Slides were delivered on birds, animals, insects and plants at different schools, colleges and training colleges for teachers.

General Remarks:

As a follow up of the Nature Education Organiser's visit to U.S.A. and U.K. an action plan for improving Nature Education methods was prepared.

The concentration should be on Nature Orientation courses.

Donations:

The Nature Education Organiser received several educational packages from different Zoos and Institutions while touring U.S.A. and U.K. The International Centre for Environmental Education has kindly donated 10 audio-visual programmes to the Scheme. Mr. Bittu Sahgal, Hon Treasurer, BNHS has donated 7 packages of audiovisuals on different natural history subjects prepared by the National Geographic Society, U.S.A.

Donations

The Society is deeply grateful to the following Institutions, Organisations and individuals for substantial donations towards the activities and welfare of the Society.

General donation:

Mr. I. R. Mehta	2000.00
Parashwanath Sami Digambar Jain Mandir Trust	500.00
Shri T. Gangdeb	300.00
Less than Rs. 200/-	1972.35

Sir Dorabjee Tata Trust for binding Library Books	10000.00
Salim Ali Nature Conservation Fund:	
B.B.C. Enterprises	2469.60
Anonymous	3000.00
Mr. V. Nanjundiah	400.00
Charles McCann Fund:	
Mr. S. Chaudhury	600.00
Plant Study Fund:	
Mr. S. Joseph Wright	586.87
Others less than Rs. 50/-	100.00
For Hornbill Newsletter	
Seth Purushottamdas Thakurdas Divaliba Charitable Trust	25000.00

We are very grateful to Tata Engineering & Locomotive Company for the donation of a bus for our field and educational activities.

Grants

Air Conditioning of collection rooms & Library:

On a representation being made on the national status and importance of the collections and the specialist library of the Society, the Government of India was pleased to make a non-recurring grant of Rs. 9 lakhs towards the cost of installing an airconditioning system for the better maintenance of these assets.

Research

National Centre for Ornithology and Environmental Conservation:

The Government of India, in recognition of the Society's pioneer efforts in the study of ornithology and nature conservation has identified the Society as the agency to establish a national centre of excellence in these fields. The Centre will be fully funded by the Central Government and organised and administered by a Society to be set up by us with majority membership in the Governing Council.

Studies on the movement and population structure of Indian Avifauna:

Ringing of birds at Bharatpur was not possible in the absence of permission from the State Forest Department.

However, ringing was continued at Point Calimere where 8,284 birds were ringed. Point Calimere personnel also ran subsidiary ringing camps at Kokkarabellur in Karnataka, Thattakad bird Sanctuary, and Mootpuzha in Kerala and Mandapam-Rameshwaram in Tamil Nadu.

Recaptures at Point Calimere indicate that *Pycnonotus luteolus* is the dominant resident species, followed by *P. cafer* and *Aegithina tiphia.*

Interesting recoveries are of a *Charadrius mongolus* bearing a Hongkong ring and two *Calidris testaceus* with Moscow rings. All were released with BNHS rings.

Plant phenology, land bird communities, Insect abundance, Climatic conditions continue to be monitored.

An Ecological Study of Bird Hazards at Indian Aerodromes Work at Aerodromes:

Examination of hazards at Dundigul, Gorakhpur, Patna, Nagpur, Kalaikunda, Calcutta, Tezpur, and Chalnawa commenced. Over 3,000 copies of the booklet on birds hazards to aircraft were distributed. The problems underlying the projects to band vulture and to study them under captive conditions were still unresolved.

Ecology of Certain Endangered Species of Wildlife and Their Habitats:
Great Indian Bustard:

Recommendations for the conservation of the Bustard in the Karera Sanctuary were prepared as a technical report and circulated.

The Survey of the bustard in Gujarat was completed and prepared as a technical report.

The Survey of the Jerdon's Courser habitat was published as a technical report.

The annual reports of the Bustard and Florican studies were published during the year.

Elephant:

The study of the elephant and its habitat with the object of preparing a management plan for the Mudumalai Sanctuary and generally prepare guidelines for elephant management is in progress. The report for the year's activities was completed and published.

Hydrobiological (Ecological) Research Station at Keoladeo Ghana National Park, Bharatpur:

The study of the Ecology of the Bharatpur Avian habitat entered its 5th year. Considerable data has been collected on all parameters and the factors which influence the ecology of the sanctuary are now becoming evident.

Reference Collection

During the year 134 specimens were registered into the collections.

Birds	55
Frogs & Toads	46
Lizards	25
Snakes	6
Mammals	2
	134

Library

During the year 1985, 251 books were added to the Society's Library of which 163 were donated. 32 were received as complimentary copies and 12 for review. 35 books were purchased for the library and 9 books were purchased for the projects.

We are very grateful to Mrs. Sam Berkeley-Hill who donated to the Society the excellent personal library of her late husband.

Revenue and Accounts

The financial situation of the Society continued to a cause for concern though the year's working showed a small surplus of Rs. 21,514.96.

Staff

The Committee wishes to record its appreciation of the willing co-operation of the staff in the activities of the Society.

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950
SCHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1985

FUNDS AND LIABILITIES

Trust Fund or Corpus:		
Life Membership Fund (individual):		
Balance as per last Balance Sheet	3,86,991.23	
Add: Amount received during the year	83,731.38	4,71,722.61
Corporate Life Membership Fund:		
Balance as per last Balance Sheet	2,00,661.31	
Add: Amount received during the year	5,881.00	2,06,542.31
Vice Patron Fees:		
Balance as per last Balance sheet		42,769.00
Other Earmarked Funds:		
Created out of the income As per Schedule 'C'		26,84,854.86
Other Funds:		
As per Schedule 'A'		7,18,898.86
Liabilities:		
For unspent grants as per Scheduel 'B'	18,70,296.27	
For expenses	5,16,961.38	
For Library Deposits	1,650.00	
For Sundry Credit Balances	20,317.14	
For Advances for publications	18,246.85	24,27,471.64
Carried over		65,52,259.28

ASSETS

Immovable Properties:		Nil
Investments (At appropriate value):		
Government securities (At cost):		
3% Conversion Loan 1946/86 at the face value Rs. 25,000/- (Market value Rs. 24,025/-)	25,000.00	
$5\frac{1}{2}$% Govt. of India Loan 2000 of the face value Rs. 2,000/- (Market value Rs. 1,380)	2,000.00	
2911.736 UNITS of the Unit Trust of India under re-investment plan of the face value of Rs. 100/- each (Total face value Rs. 2,91,173.6)	2,93,740.42	3,20,740.42
Motor Cars, Motor Cycles & Auto Cycles:		
Balance as per last Balance Sheet	1,228.58	
Less: Depreciation during the year	245.70	
Mini Bus received as donation during the year (value not brought into accounts)		982.88
Furniture, Texture & Equipment:		
Balance as per last Balance Sheet	91,316.66	
Additions during the year	9,918.10	
	1,01,234..76	
Less: Depreciation during the year	12,654.35	88,580.41
Carried over		4,10,303.71

FUNDS AND LIABILITIES		
Brought over		65,52,259.28
Other Advances:		
(Amount received for and on behalf of the proposed institute)		
Balance as per last Balance Sheet	2,48,750.08	
Add: Interest credited during the year	20,000.00	
	2,68,750.08	
Less: Expenditure for & on account of the Institute incurred during the year	20,458.05	2,48,292.03
Income and Expenditure Account:		
Excess of income over expenditure Transferred from Income & Expenditure account during the year	21,514.96	
Less: Deficit as per last Balance Sheet	17,787.76	3,727.20
Carried over		68,04,278.51

ASSETS		
Brought over		4,10,303.71
Loans (Unsecured considered good):		
To Employees		15,595.00
Advances (Unsecured considered good):		
To Trustees (for expenses)	—	
To employees (for project expenses)	1,59,578.79	
To employees for other Society's expenses	14,702.00	
To Others	555.00	
To Nature Education Scheme	17,141.62	1,91,977.41
Suspense Account:		
Hydrobiology project (considered doubtful)		28,860.15
Stocks:		
A) Publications as per inventory taken & certified by the Honorary Secretary at or below cost	7,92,978.19	
B) Safety cartridges (as certified by the Honorary Secretary)	9530.35	
C) Book on New Indian Trees (under preparation)	5,001.90	8,07,510.44
Carried over		14,54,246.71

FUNDS AND LIABILITIES		ASSETS		
Brought over	68,04,278.51	Brought over		14,54,246.71
		Income Outstanding:		
		Interest Accrued	69,512.20	
		Supplies & Services	1,81,430.41	
		Grant Government of Maharashtra 1985/86	1,70,946.00	
		Grant Govt. of India, Dept. of Science & Technology for 1985/86	40,000.00	
		Grant Indian National Science Academy for 1985/86	5,000.00	
		Grant U.S. Dept. of Interior Fish & Wild life service — National park on the study of ecology of certain endangered species of wild life & their habitats.	3,34,075.00	8,00,963.61
		Income Tax Refundable:		20,770.00
		Cash and Bank Balances:		
		As per Schedule 'D' including Rs. 1,84,400 in fixed deposits.		45,28,298.19
Total	68,04,278.51	Total		68,04,278.51

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- BITTU SAHGAL,
Honorary Treasurer,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, 8*th December*, 1986.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER, 1985

	Name of the Fund	*Balance as per last Balance Sheet* (1)	*Amount received appropriated during the year* (2)	*Interest credited during the year* (3)	*Total of columns 1, 2 & 3* (4)	*Expenditure on objects of the Society as shown in income & Exp. A/c* (5)	*Balance as at 31st December 1985 (4 minus 5)* (6)
(1)	Staff Welfare fund	35,822.84	—	—	35,822.84	—	35,822.84
(2)	Interest on Col. Burtons Nature Conservation fund investment	61.06	—	300.00	361.06	333.48	27.58
(3)	Charles McCann Vertebrate Zoology field work fund	56,999.85	600.00	5,699.68	63,296.53	5,544.16	57,752.37
(4)	Salim Ali Nature Conservation fund for silent valley expenses	11,341.97	—	—	11,341.97	—	11,341.97
(5)	Hospitality fund from Dr. Salim Ali	360.37	—	—	360.37	—	360.37
(6)	Projector fund received from members	968.04	—	—	968.04	715.80	252.24
(7)	Scholarship fund under Salim Ali/ Loke Wan Tho Ornithological Research fund Investment	7,325.76	—	32,113.65	39,439.41	13,753.77	25,685.64
(8)	Interest on Salim Ali Nature Conservation fund investment	80,668.33	—	62,934.33	1,43,602.66	11,322.12	1,32,280.54
(9)	Interest on field work fund under Pirojsha Godrej foundation fund investment	—	—	4,000.00	4,000.00	920.51	3,079.49
(10)	Field work fund Sir Dorabjee Tata Trust	10,000.00	—	—	10,000.00	—	10,000.00
(11)	For Library books binding from Sir Dorabjee Tata Trust	—	10,000.00	—	10,000.00	6,968.06	3,031.94
	Carried over	2,03,545.22	10,600.00	1,05,047.66	3,19,192.88	39,557.90	2,79,634.98

SCHEDULE 'A' (Contd.)

	Name of the Fund	(1)	(2)	(3)	(4)	(5)	(6)
	Brought over	2,03,545.22	10,600.00	1,05,047.66	3,19,192.88	39,557.90	2,79,634.98
(12)	Field study & scholarship fund from Watanmal Boolchand Charitable Trust	15,000	—	—	15,000.00	—	15,000.00
(13)	Photography exhibition fund received from Shri M. Y. Ghorpade of Sandur	10,000.00	—	—	10,000.00	—	10,000.00
(14)	Interest on Plant study fund investment	2,633.26	—	9,030.23	11,663.49	10,556.30	1,107.19
(15)	Education & Research fund (created out of income)	96,196.16	2,67,356.42	—	3,63,552.58	—	3,63,552.58
(16)	Mini Bus maintenance fund (Transferred as per income & expenditure account)	—	9,604.11	—	9,604.11	—	9,604.11
(17)	Library Fund (created out of income during 1985)	—	40,000.00	—	40,000.00	—	40,000.00
	Total	3,27,374.64	3,27,560.53	1,14,077.89	7,69,013.06	50,114.20	7,18,898.86

SCHEDULE 'B'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER, 1985

	Name of the Grant	*Unspent/(over spent) balance as per last balance sheet*	*Amt. received/ due during the year*	*Unspent bal. carried to next year*	*Income for the year as credited to Income Exp. Account*	*Amount spent during the year*
		(1)	(2)	(3)	(4)	(5)
(1)	Grant Govt. of India, Ministry of Defence, Aeronautics Research & Development Board for ecological study of Bird Hazard at Indian Aerodromes.	1,00,090.93	7.51,000.00	88,393.12	7,62,697.81	7,62,697.81
(2)	*GRANTS FROM*: U. S. Department of Interior, Fish & Wildlife Service—National Park Service:					
	i. Studies on the movement & population structure of Indian Avifauna	(19,277.63)	6,03,790.00	2,74,132.03	3,10,380.34	3,10,380.34
	ii. Hydrobiological (Ecological) Research station at Keoladeo Ghana Sanctuary, Bharatpur.	1,64,519.97	6,58,240.00	1,69,557.82	6,53,202.15	6,53,202.15
	iii. Study of Ecology of certain endangered species of wildlife & their habitats.	1,58,332.04	3,34,075.00	1,950.21	4,90,456.83	4,90,456.83
	iv. Study of Lesser Bustard (Florican) *Sypheotides indica* and the Bangal Florican *Eupodotis bengalensis*	4,42,059.34	—	89,698.53	3,52,360.81	3,52,360.81
(3)	Grant from Chief Wildlife Warden, Chandigarh, Punjab for Bird ringing project at Harike.	41,115.11	28.215.00	59,316.26	10,013.85	10,013.85
(4)	Grant Chief Wildlife Warden, Bhubaneshwar, Orissa, for Bird ringing project at Chilka	(17,506.56)	26,200.00	6,110.86	2,582.58	2,582.58
	Carried over	9,06,117.39	24,01,520.00	6,89,158.83	25,81,694.37	25,81,694.37

SCHEDULE 'B' (Contd.)

	Name of the Grant	(1)	(2)	(3)	(4)	(5)
	Brought over	9,06,117.39	24,01,520.00	6,89,158.83	25,81,694.37	25,81,694.37
(5)	Grant Govt. of India, Dept. of Environment for the expenses on Secretarial assistance to Dr. Salim Ali for environmental Research programme for processing the Archival material	(13,255.62)	27,373.00	355.88	13,761.50	13,761.50
(6)	Grant Govt. of India, Dept. of Science & Technology for Bird data Analysing study for 1984-85 contd. till 1985-86	11,413.56	—	—	11,413.56	11,413.56
(7)	Grant Govt. of India, Dept. of culture for publishing the centenary seminar papers of the Society 1984-85 contd. till 1985-86	29,764.90	—	29,764.90	—	—
(8)	Grant Govt. of India, Dept. of Science & Technology for the publication of Encyclopedia of Indian Natural History 1984-85 contd. till 1985-86	1,02,351.20	—	99,214.70	3,136.50	3,136.50
(9)	Grant Govt. of India, Dept. of Environment for Research Programme during 1984-85 (received in 1985-86)	—	2,55,000.00	—	2,55,000.00	2,55,000.00
(10)	Grant Collector of Thana for conducting Educational compaign 'Nisarga yatra'	—	10,000.00	—	10,000.00	10,000.00
(11)	Grant Govt. of India, Dept. of Environment for Air conditioning the Hornbill House, Library and Collection rooms	—	9,00,000.00	9,00,000.00	—	—
(12)	Grant Govt. of India for Building repairs for 1984-85 till 1985-86	15,800.56	—	—	15,800.56	15,800.56
	Carried over	10,65,447.61	35,93,893.00	17,18,494.31	28,90,806.49	28,90,806.49

SCHEDULE 'B' (Contd.)

	Name of the Grant	(1)	(2)	(3)	(4)	(5)
	Brought over	10,65,447.61	35,93,893.00	17,18,494.31	28,90,806.49	28,90,806.49
(13)	Grant Govt. of India, Dept. of Science and Technology for the publication of Journal 1985-86	—	40,000.00	—	40,000.00	40,000.00
(14)	Grant Indian National Science Academy for the publication of Journal during 1985-86	—	5,000.00	—	5,000.00	5,000.00
(15)	Grant Govt. of Maharashtra for the publication of Journal (Educational Activity) during 1985-86	—	4,000.00	—	4,000.00	4,000.00
(16)	Grant Govt. of Maharashtra for Environment & Building maintenance:					
	1) For 1984-85	50,330.80	—	—	50,330.80	50,330.80
	2) For 1985-86	—	1,66,946.00	39,019.20	1,27,926.80	1,27,926.80
(17)	Grant Govt. of Maharashtra for Building repairs for 1983-85 contd. till 1985-86	1,23,000.00	—	1,12,782.76	10,217.24	10,217.24
	Total	12,38,778.41 (50,039.81)	38,09,839.00	18,70,296.27	31,28,281.33	31,28,281.33*

* *Note*

Towards	Property expenses	37,960.20
,,	Establishment expenses	1,66,315.20
,,	Educational objects	28,75,005.93
,,	Journal expenses	49,000.00
		31,28,281.33

SCHEDULE 'C'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER, 1985

	Name of the Funds		*Balance as per last Balance sheet* (1)	*Amount received during the year* (2)	*Total of Column 1 & 2* (3)	*Transfer to income & Exp. a/c. as shown in the income & Exp. a/c.* (4)	*Balance as at 31st December 1985 (3 minus 4)* (5)
(1)	Fixed Assets Fund		42,978.62	—	42,978.62	12,900.05	30,078.57
(2)	Building Fund		1,03,227.68	10,000.00* (Interest)	1,13,227.68	10,000.00	1,03,227.68
(3)	General Reserve Fund		37,952.71	—	37,952.71	—	37,952.71
(4)	Provision for Depreciation on Investment		9,266.10	—	9,266.10	—	9,266.10
(5)	Provision for Capital losses		15,025.23	—	15,025.23	—	15,025.23
(6)	Publication Fund (BNHS)		8,84,317.36	—	8,84,317.36	—	8,84,317.36
(7)	Govt. of India, Dept. of Science & Technology Publication Fund:						
	i) Sale proceeds of Century of Natural History	Rs. 4,193.83					
	ii) Sale proceeds of Book of Indian Reptiles	,, 15,570.86	73,032.58	19,764.69	92,797.27	—	92,797.27
(8)	Salim Ali/Loke Wan Tho Ornithological Research Fund		3,21,136.52	—	3,21,136.52	—	3,21,136.52
(9)	Col. Burton's Nature Conservation Fund		3,000.00	—	3,000.00	—	3,000.00
(10)	Sir Pirojsha Godrej Foundation field work Fund		40,000.00	—	40,000.00	—	40,000.00
(11)	Salim Ali Nature Conservation fund		6,29,343.31	5,869.68	6,35,212.99	—	6,35,212.99
(12)	Plant study fund		90,302.37	686.87	90,989.24	—	90,989.24
(13)	Staff Gratuity fund		2,56,828.00	25,682.80*	2,82,510.80	—	2,82,510.80
(14)	Centenary celebration fund		89,340.39	—	89,340.39	—	89,340.39
(15)	Hornbill Newsletter fund		50,000.00	5,000.00*	55,000.00	5,000.00	50,000.00
	Total		26,45,750.87	67,004.04	27,12,754.91	27,900.05	26,84,854.86

* INTEREST

SCHEDULE 'D'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER, 1985

CASH AND BANK BALANCES		
A) *In Current account with*:		
i) Grindlays Bank PLC M. G. Road, Bombay-40 023	2,54,538.53	
ii) Grindlays Bank PLC London. (£. 1742.08) @ Rs. 17.15	29,876.67	
iii) Chartered Bank, M. G. Road, Bombay-400 023	2,44,105.06	5,28,520.26
In Savings account with:		
iv) Grindlays Bank PLC. M. G. Road, Bombay-400 023	11,24,576.23	
v) Bank of India, Museum Savings Branch, Bombay-23	1,04,367.16	
vi) Bank of Baroda, University Branch, M. G. Road, Bombay-400 23	3,71,939.11	
vii) Corporation Bank, Dalal Street, Bombay-400 023	5,54,895.43	21,55,777.93
B) *In Fixed Deposit with*:		
i) Bank of India, M. G. Rd., Bombay-400 023	1,14,000.00	
ii) Chartered Bank, M. G. Road, Bombay-400 023.	1,00,000.00	
iii) Bank of Baroda, University Branch, M. G. Road, Bombay-400 23	1,00,000.00	
iv) Corporation Bank, Dalal Street, Bombay-400 023.	6,00,000.00	
v) Grindlays Bank PLC. M. G. Rd., Bombay-400 023	1,55,000.00	
C) *In Monthly Certificate with*:		
Bank of India, M. G. Road Branch, Bombay 400 023.	7,75,000.00	18,44,000.00**
Total		= 45,28,298.19

***Includes earmarked against the following funds*:	
a) Dr. Salim Ali/Loke Wan Tho Ornithological Research Fund	3,21,136.00
b) Dr. Salim Ali Nature Conservation Fund	6,35,212.00
c) Pirojsha Godrej Foundation Fund	40,000.00
d) Charles McCann Vertebrate Zoology field work fund	57,752.00
e) Building Fund	1,00,000.00
f) Staff Gratuity Fund	2,82,510.00
g) Hornbill News letter fund	50,000.00
h) Plant study fund	90,989.00
i) Col. Burton's Nature Conservation Fund	3,000.00
Total Rs.	15,80,599.00

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT, 1950

SCHEDULE IX VIDE RULE 17(1)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1985

EXPENDITURE

To *Expenses in Respect of Properties*:			
,, *Rates & taxes*: Met out of grant Govt. of Maharashtra 1985-86		4,826.00	
,, *Repairs & Maintenance*:			
a) Met out of grant Govt. of India, Dept. of Science & Technology 1984-85 contd. till 1985	15,800.56		
b) Met out of grant Govt. of Maharashtra 1984-85 contd. till 1985-86	10,217.24	26,017.80	
,, Insurance (on building)		323.00	
,, *Other Contingency Expenses*: Met out of grant Govt.			
of Maharashtra for 1984-85	3,619.40		
-do- for 1985-86	3,174.00	6,793.40	
,, *Other Contingency Expenses*: Contingency expenses, electricity charges, etc. including Rs. 10,000/- charged to Building fund (as per contra)		27,947.60	65,907.80
Carried over			65,907.80

INCOME

By *Rent* (Accrued & Realised)		Nil
,, *Interest* (Accrued & Realised)		
On Securities	860.00	
On Fixed Deposits & Bank account (including Rs. 1,74,760.69 on earmarked funds)	2,82,450.19	2,83,310.19
,, *Dividends* (on Units of Unit Trust of India):		34,220.66
,, *Donations* (in cash or kind): General donations		4,772.35
,, *For specific Funds*:		
Charles McCann vertebrate zoology field work fund	600.00	
Salim Ali Nature Conservation Fund	5,869.68	
Plant study fund	686.87	
Dorabjee Tata Trust, for binding Library Books	10,000.00	17,156.55
Donation from Seth Purushotamdas Thakurdas & Divaliba Charitable Trust towards publication of Hornbill News letter		25,000.00
Carried over		3,64,459.75

EXPENDITURE

Brought over			65,907.80
To *Establishment Expenses*:			
A) Salaries including D.A. etc. met out of grant Govt. of Maharashhtra			
for 1984-85	Rs. 46,388.40		
for 1985-86	1,19,926.80	1,66,315.20	
B) Salaries including D.A. etc. other than above		4,40,517.25	
Society's contribution to Staff Provident Fund		15,179.00	
Postages		11,795.73	
Printing & Stationary		30,600.42	
Advertisement		1,805.00	
Telephone Rental & Call charges		5,144.19	
Meeting expenses		6,135.25	
Conveyance & travelling exps. (Local)		3,426.75	
Bank charges		135.20	
Wages (local labour)		880.00	
Medical expenses to staff members		8,300.00	
Leave travel expenses to staff members		937.80	
			6,91,171.79
,, *Audit Fees*:			1,000.00
Carried over			7,58,079.59

INCOME

Brought over		3,64,459.75
By *Other Donations*:		
Life membership fees (individual)	84,731.38	
Corporate Life memvership fees	5,881.00	
Donation of Mini Bus from M/s. Tata Engineering & Locomotive Co. Ltd., of which value not brought in to books)	——	90,612.38
,, *Grants* (As per Schedule 'B'):		31,28,281.33
,, *Income from Subscriptions & Entrance Fees*:		
Membership subscriptions (individual)	1,30,296.26	
Corporate membership subscriptions	39,757.46	
Student Membership subscriptions	2,380.00	
Subscriptions to Journal (Non members)	42,592.15	
Entrance fees	13,425.00	2,28,450.87
,, *Income from Publications*:		
Journal Sales	8,783.95	
Book of Indian Birds	27,947.25	
Book of Indian Animals	40,224.90	
Some Beautiful Indian Trees	3,003.00	
Some Beautiful Indian Climbers and Shrubs	4,408.60	
Identification of poisonous Snake Charts	195.00	
Synopsis of the Birds of India & Pakistan	1,046.00	
Grasses of western India	811.00	
Butterflies of Indian Region	1,739.00	
Carried over	88,158.70	38,11,804.33

EXPENDITURE

	Brought over		7,58,079.59
To	*Amounts Written off*:		
	Bad Debts		493.90
,,	*Miscellaneous Expenses*:		
	General contingency expenses	3,841.20	
	Insurance Premium (Fire & Accidental)	2,639.00	
	Repairs to Furniture and equipment	2,677.35	
	Garden maintenance expenses	912.00	
	Retainers fees	18,000.00	
	Expenses on printing the proposed amendment to Society's rules & regulations	6,750.00	
	Audio visual	372.00	35,191.55
,,	*Depreciation*:		
	On Furniture & Equipments	12,654.35	
	On Motor Cars, Motor cycle & Auto cycle	245.70	12,900.05
,,	*Amounts Transferred to Reserve or Specific Funds*:		
	Donations towards specific funds transferred to relevant fund Account in the Balance sheet	17,156.55	
	Life membership fees transferred to Life membership fund account in the Balance sheet	84,731.38	
	Corporate Life membership fees transferred to Corporate Life membership fund account in the Balance sheet	5,881.00	
	Carried over	1,07,768.93	8,06,665.09

INCOME

	Brought over			38,11,804.33
By	*Income from Publications* (Contd.)			
	Brought over		88,158.70	
	Hornbill stickers		468.00	
	Nature calendars		69,089.89	
	Other Publications (Outside publications)		13,411.31	
	Book of Indian Reptiles		15,570.86	
	A Century of Natural History		4,193.83	
	Greeting Cards		2,67,356.42	4,58,249.01
,,	*Miscellaneous Income*:			
	Miscellaneous receipts (general)		2,835.30	
	Nett receipts received from members Nature camps arranged during the year			
	Total receipts	Rs. 61,593.45		
	Less expenses	Rs. 51,989.34	9,604.11	
	Exchange fluctuation, Grindlays Bank account London		3,004.52	15,443.93
,,	*Administrative Fees*:			
	For handling the greeting card sales account		37,003.14	
	For handling the 'A Century of Natural History' publication sales		1,107.15	
	For handling the 'Book of Indian Reptiles' publication sales		3,604.95	
	For handling project funds		2,64,868.54	
	For handling other earmarked fund accounts		8,954.74	3,15,538.52
	Carried over			46,01,035.79

EXPENDITURE			
Brought over			8,06,665.09
To *Amount Transferred to Reserve or Specific Funds* (Contd.) Brought over		1,07,768.93	
,, *Sale proceeds of Publications*: Government Publication fund:			
1) A Century of Natural History	4,193.83		
2) Book of Indian Reptiles	15,570.86	19,764.69	
Interest on Fixed deposits transferred to respective funds in the Balance sheet		1,74,760.69	
,, *Appropriations to Specific Funds*: Education & Research Fund surplus from greeting cards transfer		2,67,356.42	
Mini Bus Maintenance Fund surplus from Nature camps transferred		9,604.11	
,, *Provisions*: For Library expenses provided from Income & Expenditure account		40,000.00	6,19,254.84
Carried over			14,25,919.93

INCOME		
Brought over		46,01,035.79
By *Amount Transferred from Specific Funds*: From Building fund towards expenditure on Building maintenance	10,000.00	
From Hornbill News letter fund towards expenditure on Hornbill News letter publication	5,000.00	
From Fixed Assets Fund towards depreciation (per contra)	12,900.05	
From various specific funds towards expenses on objects (as per contra vide Schedule 'A')	50,114.20	78,014.25
Carried over		46,79,050.04

EXPENDITURE			INCOME	
Brought over		14,25,919.93	Brought over	46,79,050.04
To *Expenses on Objects of the Trust*: Educational: met from:				
i) respective funds as per Schedule 'A'	50,114.20			
ii) Expenses met out of grants on objects of the trust as per Schedule 'B'	28,75,005.93			
iii) For publishing the Journal of the Society (includes Rs. 49,000/- met from specific grants as per Schedule 'B'	2,32,403.27			
iv) For publishing Hornbill News letter including Rs. 5,000/- charged to Hornbill Sews letter fund (as per contra) and Rs. 25,000/ special donation from Seth Purushotamdas Thakordas Divaliba Charitable Trust	58,746.49	32,16,269.89		
" *Library Account*:				
Subscription to other Societies	607.93			
Purchase of books	3,193.28	3,801.21		
" *Field Programme & Other Field Study Expenses and Members Activity*:		8,795.85		
" *Maintenance of Reference Collections*: Excess of income over expenditure carried to Balance Sheet		21,514.96		
Total		46,79,050.04	Total	46,79,050.04

BOMBAY, 8*th December*, 1986.

Sd/- BITTU SAHGAL,
Honorary Treasurer,
BOMBAY, 8*th December*, 1986.

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31*ST DECEMBER*, 1985

RECEIPTS		
To *Balance As at 1st January*, 1985		
With Grindlays Bank PLC Bombay on Current Account.	4,793.96	
With Nature Education Organiser	200.00	4,993.96
„ *Grants*:		
Government of Maharashtra for the year 1985-86		24,594.00
„ *Sale of Nature Study Booklets*:		395.75
Advance from Bombay Natural History Society		17,141.62
Total		47,125.33

PAYMENTS		
By Refund of advance from Bombay		16,547.37
„ Salary (Nature Education Organiser)		24,849.35
„ General charges		3,100.65
„ Printing & Stationery		902.20
„ Postages		1,091.90
„ *Balance as at 31st December*, 1985		
i) With Grindlays Bank PLC, Bombay on Current Account	433.86	
ii) Cash on hand with Nature Education Organiser	200.00	633.86
Total		47,125.33

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- BITTU SAHGAL,
Honorary Treasurer,
Bombay Natural History Society

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, 8*th December*, 1986.

THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY WAS HELD ON TUESDAY, THE 30TH DECEMBER 1986 AT 6.00 P.M. AT HORNBILL HOUSE, WHEN THE FOLLOWING MEMBERS WERE PRESENT:

1. Prof. D. N. Kulkarni
2. Mr. J. C. Daniel
3. Mr. M. R. Almeida
4. Mr. J. P. Irani
5. Mr. N. D. Mulla
6. Dr. Robert B. Grubh
7. Mr. M. A. Rashid
8. Mr. M. D. Agharkar
9. Mr. Kisan Mehta
10. Dr. R. Reuben
11. Mr. S. D. Swatantra
12. Dr. E. K. Bharucha
13. Mr. H. Mukherjee
14. Mr. Sam J. Bhacka
15. Mr. Bittu Sahgal
16. Mr. Cyrus Guzder
17. Mr. Humayun Abdulali
18. Ms. P. Mukherjee
19. Dr. C. V. Kulkarni (in the chair)
20. Mr. Ulhas Rane
21. Mr. S. R. Nayak
22. Mr. Nitin Jamdar
23. Mr. Debi Goenka
24. Mr. S. N. Mistry
25. Mr. M. K. Mistry
26. Dr. A. N. D. Nanavati
27. Ms. M. M. Haribal
28. Mr. S. A. Hussain
29. Mr. A. L. Hegde
30. Mr. N. P. Behramfram
31. Ms. Heta Pandit
32. Mr. K. N. Naoroji
33. Mr. V. James
34. Mr. H. C. Mistry
35. Cdr. G.V.K. Unnithan
36. Mr. G. L. Kalro
37. Mr. R. A. Acharya
38. Mr. Suresh G. Bhatkal
39. Mr. A. V. Ghangurde

In the absence of the President, the Honorary Secretary, Dr. A. N. D. Nanavati, requested Dr. C. V. Kulkarni, the Senior Vice President present at the meeting to take the Chair. Shri Bittu Sahgal supported the suggestion.

The Chairman welcomed the members and later drew attention of the members present to the recent death of Mr. G. V. Bedekar, I.C.S. (Retd.) a former Vice President of the Society, and of Mr. R. S. Dharmakumarsinhji who had served both on the Executive and Advisory Committees of the Society for many years. A two minutes' silence was observed, all standing, as a mark of respect to their memory.

Agenda item 1:

The Chairman advised that in accordance with Resolution 5 of the adjourned A.G.M. held on 31st January 1986, the draft of the minutes of the last A.G.M. were to be confirmed in the following A.G.M. They were also to be circulated among members present at that meeting. After this was done, comments from seven members were received and forwarded to the Chairman of the meeting for his consideration. The finalised minutes were being placed before the meeting for confirmation.

Mr. N. D. Mulla raised the objection that note had not been taken of the comments he had made on the draft minutes. The Chairman, in reply, read out the letter of Prof. P. V. Bole, the Vice President, who had presided over the 1984 A.G.M. Prof. Bole had remarked that it was not possible to produce verbatim reports in the minutes. The comments made by members on the draft, were considered and that the minutes as drafted presented the correct summary of the discussion.

There being no other queries on the minutes circulated, they were confirmed.

The Chairman requested the Honorary Secretary to present the report for the year ending 1985. The annual report which had been circulated among those present was taken as read. The Honorary Secretary drew attention to the rediscovery of the Golden Gecko in 1985, after an interval of 117 years after its original description. The rediscovery had been inadvertently omitted from the 1985 report.

The Honorary Secretary then made some supplementary remarks on items of interest that had occurred after the year of the report, namely,

a) Progress made in the negotiations regarding setting up of the Centre for Ornithology, the legal aspects of which are now being worked out.
b) The rediscovery of Jerdon's Courser in Andhra Pradesh under the Society's Endangered Species Project.
c) The conferring of the Order of the Commander of the Golden Ark on Dr Salim Ali by Prince Bernhard of the Netherlands for his work on Nature Conservation.
d) He further stated that the fear that nuclear fall-out from Chernobyl might have contaminated the migratory birds which came to India, and that such migrants could be a danger when they arrive in India had been set at rest, as migrant species collected at Bharatpur had been got tested at the Bhabha Atomic Research Centre, Bombay, and found negative for radiation. They were later ringed and released.

The Honorary Secretary thanked the donors of major donations received during 1986. The details would be presented in 1986 annual report.

He also gave the welcome news that the Encyclopedia of Indian Natural History would be released on 10th January 1987.

During the discussion on the report Mr. Humayun Abdulali drew attention to the fact that the Centre for Ornithology would not be a part of the Bombay Natural History Society as originally envisaged but would work independently of it. The Honorary Secretary explained that it was the unanimous decision of the Executive Committee of the Society that as the proposed institute would be 100% funded by Government, it would have government representatives on its Governing Board. The Executive Committee felt that the Centre should be separate from the Society to permit the Society remain an independent non-governmental body. However, the Society would have the majority interest in the administration of the Centre.

The Honorary Secretary's report was then adopted.

Agenda item 2:

The Chairman requested the Honorary Treasurer to present the Balance Sheet and the Statement of Accounts. Copies had been handed over to those present, and the Honorary Treasurer, Mr Bittu Sahgal, said he would glad to answer any specific questions from members present.

Mr. N. D. Mulla wished to know why when asked for the grant for air-conditioning, Government was not asked for their views on the recurring expenses involved in the running of the air-conditioning plant, and whether to cut down on such expenses, air-conditioning could be restricted to priority sections of the Society. He was told that it was impossible to go in for further compactness in air-conditioning space. Furthermore though the matter of recurring expenses was taken up in 1983 and 1985 with Government, and verbal assurances that the recurring expenses would be met had been

received, it was only after paying the advance of Rs. 2.96 lakhs to Voltas for installing the machinery and Rs. 16,000/- to the Municipality as deposit, that the matter of recurring expenses was reopened with the Government. The Government while still agreeing to meet such expenses informed that their representation on the Society's Executive Committee would be necessary. The Honorary Treasurer advised that there was a strong feeling that such representation from Government on the Society's Executive Committee would be counter productive for the independent existence of the Society, and therefore we have to carefully consider the options before taking a final decision.

Mr. Humayun Abdulali stated that the State Government also wished to have representation on the Society's Executive Committee. He questioned the delays in making provision for these representatives. He also drew attention to the Extraordinary General Meeting held in 1985 regarding changing of the Society's rules and regulations, and wondered why no action has been taken in the matter.

The Honorary Secretary explained that for accommodating the State Government the rules of the Society have to be changed, and the amendation of rules had to be held in abeyance, until such time as final negotiations with Govt. were completed. He also pointed out that appointing of State Government representatives might need a referendum.

Mr. N. D. Mulla intervening at this stage suggested that the referendum which is being contemplated be used for dual purpose, namely for inclusion or otherwise of Government representatives, and also for amending rules and regulations of the Society.

Mr. Kisan Mehta questioned the delay in presentation of the accounts when the Government Act requires the audited accounts of the societies/charitable trusts registered under the Act only approved by the AGM to be filed with the office of Charity Commissioner within six months of the closing of the year. Failure to comply with this legal requirements exposes the Society and the Executive Committee to serious action by the government. The Chairman, Hon. Secretary and Hon. Treasurer tried to explain the difficulties encountered in timely completion, however, it was decided to get the accounts duly audited and placed before the AGM well in advance so that they can be filed with the authorities in time. Hon. Treasurer assured the compliance on time.

The accounts were accepted as presented.

Agenda item 3:

Messrs Habib & Co. were reappointed as auditors of the Society for ensuing year, on the same remuneration, with Mr. Kisan Mehta supporting the suggestion of the Honorary Treasurer.

Agenda item 4:

Mr. Nitin Jamdar drew attention to the need to display a board on the Society's building giving its name as HORNBILL HOUSE. This was agreed to.

The meeting terminated with a vote of thanks.

THE SOCIETY'S PUBLICATIONS

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. (*Price to members Rs.* 70)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*Price to members Rs.* 75)

A Pictorial Guide to the Birds of the Indian Subcontinent, by Sálim Ali & S. Dillon Ripley (available to members @ Rs. 115.00)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Bhutan, Bangladesh and Sri Lanka. 2nd edition. (*Price to members Rs.* 80)

Checklist of the Birds of Maharashtra, by Humayun Abdulali, 2nd edition. Rs. 4

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

The Book of Indian Reptiles, by J. C. Daniel (*Price to members Rs.* 85)

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). (*Price to members Rs.* 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*Price to members Rs.* 85)

Grasses of Western India, by Toby & Patricia Hodd. With 64 monochrome plates. (*Price to members Rs.* 37.50)

Encyclopedia of Indian Natural History, Edited by R. E. Hawkins (*Price to members Rs.* 215)

A Century of Natural History, Edited by J. C. Daniel (*Price to members Rs.* 145)

Glimpses of Nature Series Booklets:

1. Our Birds I (with 8 coloured plates) in Kannada — Rs. 0.65
2. Our Monsoon Plants (with 8 coloured plates) in Hindi and Marathi. — Rs. 0.80
3. Our Animals (with 8 coloured plates) in Gujarati, and Hindi. — Rs. 1.25

TERMS OF MEMBERSHIP

Entrance Fees:	
Ordinary and Life Members	Rs. 50
Student Members	Rs. 10
Subscription:	
(*a*) Ordinary individual Members	Rs. 75
(*b*) Ordinary Corporate Members	Rs. 250
(*c*) Ordinary Members resident outside India	Rs. 350
Life Members	Rs. 1200
	(Rs. 250 after 20 years)
Life members resident outside India	Rs. 5000
Student Members (without Journal)	Rs. 25
Annual subscription to Journal	Rs. 270

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 15 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 13, St. James's Sq., London SW1Y 4LF. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

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